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PRACTICAL
LESSONS IN PSYCHOLOGY

BY

WILLIAM O. KROHN, PH. D. (YALE),

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CHICAGO
THE WERNER COMPANY
1894

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PREFACE.

WITHIN the past year the author has, at various institutes and other gatherings of teachers, delivered lectures on Psychology, chiefly on those phases that must and do come in for a large share of consideration on the part of every successful teacher. The speculative form which Psychology sometimes assumes found no place in those discussions, but only such features as are quite in touch with the ordinary experience of the average teacher in our common schools. The writer was surprised, and at the same time very much gratified, at the intense interest they evoked. At the solicitation of a large number of these same teachers, the lectures have accordingly been gathered together, and, with slight modifications and the advantage of much additional material, are now presented in book form.

The style has not been changed from that employed in the lectures, viz., simple, direct discourse, because the author desires that the teachers whom he has already addressed will feel that he had them in mind in preparing this book, as he had when writing the original lectures, and also that the friendly acquaintance which was thereby established shall in no wise be dampered by the high-sounding phrases that are sometimes manufactured into book language.

The terms "Mental Science" and "Psychology" are vague to the person who has not been schooled in the discussions of the purely speculative branches. But here we shall dispense with all metaphysical language and get along without technical terms.

The writer has avoided "pedagogical consciousness," "icy cognitions of thought," "primordial elements," and the like, simply because he cherishes the desire that the book shall be characterized by a practical ring rather than a scholastic rattle.

It is hoped that all who read this book, and especially the common school teacher, will consider it nothing more nor less than a collection of personal letters in which only the more important mental facts are discussed; the object and aim being to create and develop *tact* on the part of the teacher, that he may be able to read the child's mind aright and thus be better qualified to minister to the wants of the growing child-nature as this unfolds itself day by day. The greatest pedagogical need of our times is *child study*, and if the author only quickens the interest of teachers in this line he shall be more than satisfied and fully repaid for every effort he has made.

WILLIAM O. KROHN.

CHAMPAIGN, ILL., January 15, 1894.

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to-day is not made up from old musty manuscripts that have been found buried in ancient copper cylinders; its data are gained from observing the child's living, growing, active mind in all its phases as it presents itself to the teacher from day to day the year through. So, then, let me insist that you study Psychology for practical reasons. A man who intends becoming a high-class architect studies descriptive geometry, not merely because it will develop his mind but because of the use it will be to him; so you should study Psychology because you are persuaded that the knowledge gained thereby will make you a more successful teacher, *i. e.*, a more *tactful* teacher.

But you at once ask—How will it do this? How can Psychology make me a better teacher? Let us first answer the question, What is teaching? In the first place we will agree that to teach is not to *impart* instruction, for there is no way by means of which the smallest scrap of knowledge can be conveyed from the mind of the teacher to that of the pupil. Cramming facts and hearing recitations is not teaching. We all know that all education is self-education, that the child's mind must be aroused by the teacher *to act in and for itself.* To teach is to excite the child's mind to activity—*i. e.*, into activity which would not have taken place without being thus evoked.

The object and aim of all education, in home or school, is to make the best citizen possible. I mean, only that education suffices which makes a *man*—a perfected individual—rounded out, full and complete—mentally, physically, morally. Any system of education which neglects this in any respect is, just in that far, defective. We know then what we want the child to become—the
citizen. We know he is not this when he comes to school
t day, nor the second, nor the next. Indeed some of us
of ever making ideal citizens of some of our pupils—but
ould we?

here is one of the many places where Psychology helps
By adopting the methods of modern Psychology
can learn just what are the contents of the child's
tering school. He can also, by the aid of this same

experimental Psychology, ascertain the child's capacities in all the more important lines—such as the memory power, and its power of attention. The teacher, then, has two things before him—(1) the pattern, *i. e.*, the ideal citizen which he wishes the child to become, and (2) the actual child before him, *i. e.*, the raw material. But the most important matter is the third point, viz.: What methods of teaching can be best employed to convert this untutored child—this raw, crude material into the finished product—the ideal citizen? This is the most difficult question of all. This is the question that requires the most tact and skill on the part of the teacher in effecting the proper solution. But at the same time it is the question toward the solution of which Psychology contributes the most readily and furnishes the largest amount of help. Even the most crude and undeveloped Psychology will tell us to select those subjects for study that will be of the most practical use. We would hardly teach the child to sing Italian opera before we would teach it to read and spell and count. We would not insist upon it making a Delsartian bow or knowing how to waltz before teaching it some of the first principles of hygiene. Even the Indian teaches his child to bend the bow before allowing him to be adorned with feathers and paint. Humboldt tells us that an Orinoco Indian, though quite regardless of bodily comfort, will yet labor for a fortnight to purchase pigment wherewith to make himself admired; and that the same woman who would not hesitate to leave her hut without a fragment of clothing on, would not dare to commit such a breach of decorum as to go out unpainted. It is a well-known fact that colored beads and trinkets are much more prized by wild tribes than calicoes or broadcloths. Captain Speke tells us of his African attendants that they strutted about in goat-skin mantles when the weather was fine; but when it was wet took them off, folded them up and went about naked, shivering in the rain. So it is in a less degree with the young "aborigine" who presents himself at the school-room door in all parts of our broad land. He must be taught the useful, practical things. It is only thus that his mind can become better developed. It is only thus that he can be made to become what we desire him to be—the ideal man. But would you develop him in only one direction? No indeed. You are seeking for a general development of all his powers—not a single one which is to be developed at the expense of the others. Pitching baseball gives a trained eye and obedient arm and hand, and yet you want your pupil to be more than a baseball pitcher.

So, then, the real teacher, who has a true conception of his work and mission, turns to Psychology, and with its aid, and by means of its conclusions, settles three things: (1) What is this child pupil as he presents himself to me? What are the contents of his young growing mind? What are his powers and capacities as he now stands before me? (2) What do I desire him to become? Into what product should I conscientiously labor to fashion and mold him? and (3) What method must be employed in order that these aims and ideas may be realized? What knowledge is of most worth in developing the child mind into the perfected type of mental life and action? You will find that Psychology, in its modern experimental form, will be your chief help. By it you can observe the precise effect which the acquiring of this or that piece of knowledge will have on the mind, and in this way be enabled to estimate its value as an agency in unfolding the child's latent mental powers. It is, of course, very important to have an aim. You must know what you are aiming at as a teacher. Unless you have settled this you can never succeed. You may just as well tear your certificate, or other credentials, to shreds and scatter the bits to the winds, if you have not a definite purpose in mind with reference to your pupils. How could an architect build an attractive house if he began to construct it without a plan, and worked from day to day without having in mind a picture of the house he was going to build. If the blacksmith or wheelwright must have in mind an image of the thing he is about to make, how can you, as teachers, hope to succeed with the children, unless you have the st conception of what you wish them to become as a result r leadership? Of course no fixed plan can be given that all teachers in all cases and circumstances. You must make your own plan, and besides your plan you must have practical ability, *i. e.*, the ability that is gained as a result of close study and observation. When a noted general was on a famous campaign, he desired to bridge a certain swollen stream. He called his engineering corps together and told them what he wanted. They retired and were occupied many hours drawing the plans, delaying the entire army, and thus endangering the fate of the whole of that brilliant campaign. While the engineers were still at work draughting the plans, a sturdy carpenter approached the now impatient General and said, as he doffed his cap, "General, the bridge is built [and, referring to the plans], but the picter isn't drawed yet." You see the application. It is the old, well-tried principle, safe always: "*Learn to do by doing.*"

As teachers you will often find yourselves handicapped by text-books which are apt to be very inefficient. Here, as elsewhere, Psychology will come to your aid in selecting the material that will be of the most value to your pupils. We must, within limitations, draw up our own curriculum as soon as we know the mental make-up of our pupils. The order of studies that is best fitted to develop the pupils of one school may not be at all suitable in another. "Life is short"—and school life is shorter—so we are under moral obligations to so arrange the studies that the time of each pupil may be employed to the greatest advantage. To do this we must settle the relative value of different kinds of knowledge. Spencer has clearly shown that much that is called "History" in our schools is of little or no value. The law of mental progress is always from the concrete to the abstract, and yet in spite of this, highly abstract subjects, as grammar, which should come quite late, are begun very early. Political geography, with its countless definitions, dead and uninteresting to the child, is also begun in the primary grades, while physical geography, naturally attractive to the child, is in a great part passed over. The teacher must in a measure throw out those parts of the average text-book that are unimportant and supply additions to those parts that are important and useful, for the purpose of bringing about the most rapid, most healthful, child development. It is a settled fact that mind is a real, existing thing. It is also just as much an undisputed fact that the mind develops according to certain immutable laws just as the body develops in accord with certain immutable laws. If, then, the evolution of intelligence in the child conforms to laws, does it not follow inevitably that education can be rightly guided only by a knowledge of these laws? It is the height of absurdity for us to suppose that we can properly regulate the process of mental growth and development without understanding the nature of the process. The teacher who "keeps school" and is ignorant of the truths of Psychology will often withhold that class of facts that would do his pupils the most good, and at the same time forcibly administer those that are distasteful, and therefore harmful, or give them the proper subjects in the wrong way and in the wrong order. No man should pilot a boat unless he knows the nature of his craft and is familiar with the waters in which he sails. Who would ride on a railroad train if he knew its engineer to be a novice who had never before had his hand on the throttle and knew not the function of the safety valve? Or, if he were ever so skilled in the principles of steam would you trust your life to him if he knew not the system of train signals nor the rules of the road with reference to meeting and passing trains and had no "time card" before his eye? Much more might a parent trust a physician who knows nothing either of anatomy or physiology to care for his child, than to trust a so-called teacher who knows absolutely nothing of the principles according to which the mind unfolds and develops.

Remember then—*The development of children, in mind as well as in body, always obeys certain great laws; that unless these laws are in some measure conformed to by parents and teachers, mental defects will occur, and that only when these laws are conscientiously followed and completely conformed to, can the child-mind be developed to its full capacity—a mind rich in its strength and supreme power.* Judge then for yourself whether all teachers should or should not strive assiduously to learn what these laws of the best mental growth actually are.

LESSON II.

PSYCHOLOGY DEFINED AND DESCRIBED.

In the last lesson I sought to make clear to you that Psychology will help you, as teachers, along three different lines. It will help you to learn just what the average child actually is as he enters your school; it will help you to decide just what is best for this child to become, just what aim you ought to have in mind with respect to his development; and it will also help you to decide upon the best method of realizing this aim. But we have not yet answered the question — What is Psychology? To give answer to this question shall be my endeavor in this chapter.

Every text-book you pick up will, somewhere between its covers, define Psychology as the "Science of the Mind." That is the shortest definition that can be given. In fact, I think it has little else besides its shortness to commend it as a definition. For it is at once found to be insufficient in that it immediately provokes another question, viz: What is mind? And this is an exceedingly difficult question to answer clearly and in few words. You remember the story of the old philosopher who was asked, "What is matter?" and answered "Never mind." And when asked, "What is mind?" replied "No matter." But the question, "What is mind?" must not be hedged in any such way. Of course, it can not be formally defined any more than matter can be formally defined. But it can be described, and that is much better than a formal definition. We can best tell what a thing is by relating what it does. This is in a sense the whole business of Psychology — to describe the mind by telling what it does, and for that reason we shall be better able at the close of this treatise to define mind than at the beginning. But we can give a tentative definition that will certainly help us.

By the term "mind" we mean anything and everything that is comprehended under the little word "I," when we say "I think," "I desire this or that," "I feel," "I see," and the like—that is, by mind is meant *the subject of the mental states.* When you describe the orange you say—*it* is yellow, round, juicy, luscious, has weight, etc.; but—what is the orange? Why, the *thing* that has the qualities—the thing that is yellow, round, juicy, etc. So we find the mind is that real existing thing that feels, thinks, knows, perceives, desires and chooses. We know it is a non-material thing and has no existence in space as material things have. You can not touch a thought or feeling as you can the orange, but you can have just as certain, yes more certain, evidence of the real existence of mind, than you have of the existence of material things outside of us.

It is indeed the business of Psychology to tell us what the mind is—to tell us what the mind does; how it is that the mind has sensations of taste, smelling, seeing, hearing and the like; how it behaves under different conditions and surrounding circumstances; how it is affected by the different conditions and states of the body, and how it in turn affects the body. Psychology must tell us whether or not the mind acts during sleep, and if it does act during sleep, does it do so under the same conditions as in the wakeful state? Can the mind become fatigued, and if it does become tired, under what conditions can it best recover from this fatigue? Are there periods when the mind can accomplish more than at other times? Which is the best time of day for hard mental work? In how far is mind affected in its activity by the conditions of the weather, by the season of the year, by the food supply? And then, according to what laws does the mind develop—are there times of rapid growth? Does the mind develop more rapidly at six years of age than at thirteen? Which is capable of the greatest mental effort—the child whose body is growing rapidly—the overgrown child—or the child whose body is growing slowly? In which do the mental powers develop more rapidly—in the boy or girl? What are the laws of memory? Why do some people have better memories than others? Why is it that some can remember names and can not remember faces, while others can remember faces and not remember names? Why is it that some have a good memory of the eye for objects once seen, while they have no memory at all of the ear—can not remember sounds; for example, the commonest musical airs? How does it come that many children at a certain age have an inherent tendency, amounting almost to a mania, for lying? Why does corporal punishment do a few children good and injure beyond recall the mental habits and mental life of others? Why is it that the child at three years will have no feelings of fear, and will play with snakes, toads and caterpillars, while at six the same child will shrink and shudder at the very mention of such objects? Why is it that at certain ages the child has a mania for making collections of objects, *e. g.*, the boy collects arrowheads, rocks, tobacco tags and animal pets; and the girl collects remnants of gay ribbons, sea shells and buttons; while both pester their friends in endeavoring to secure a collection of foreign postage stamps? Why does it occur that a child longs to do a thing that he is told not to do, and is not particularly anxious about the task he is asked to perform? These are just a few of the questions that Psychology, in one of its departments, must answer.

There are still larger questions with which Psychology has to deal. Have animals mind? If so, is their mental life similar to ours? Do they reason, judge, compare and think as we do? These are questions that appeal for their solution to Comparative Psychology.

What is the delirium which is induced by fever or alcoholic drink? What are dreams? What are mesmerism and hypnotism? What is insanity? These are questions that belong to Morbid Psychology.

What is the relation of mental power to the size of the brain, the number and depth of its convolutions? How do the amount and quality of the blood supply affect the mental processes? Why does a sudden blow on the head make us unconscious? Why do drugs, coffee, quinine and chloroform affect the flow of the mental states? These are indicative of the questions with which Physiological Psychology is concerned.

And then there are a large class of mental activities of which we are unconscious—indeed this, I sometimes think, is the largest class. To illustrate—I am seated reading an exceedingly interesting book. I cross my legs, run my fingers through my hair or pull my handkerchief out of my pocket, and do not seem to know it, for if you should ask me a moment later if I had done these things I would say I had not, since the activities mentioned had made no impression upon me. And yet each one of these was a voluntary act. My legs did not really cross themselves—*I* crossed them. My hand did not go to my head of itself, nor did the handkerchief get from my pocket to my nose of itself—*I* did these things, and yet they were sub-conscious activities. I am at the theater and am intensely interested in the play, but to see it well I am compelled to sit in an uncomfortable seat—I am obliged to peer to the left of a pillar or to the right of a big hat, but I do not feel these discomforts till the play is over. The "bleachers" of the average baseball ground do not seem to be hard seats until the ninth inning of the game closes, when our interest subsides. You have perhaps noticed the German *Hausfrau* as she knits; it appears to be purely a mechanical action, and the knitter keeps up her knitting even when she gossips or reads. But you know, and she knows, that the knitting does not go on of itself. Notice how quickly she observes that she has "dropped a stitch." How slowly one must at first proceed while he is learning to manipulate the typewriter. How the pupil, when learning to play on the organ, while he gives attention to the "one, two, three, four" that he is counting, forgets to press the proper key or work the pedals. After a time all these things become automatic, *i. e.*, they are done sub-consciously. You or I may not be able to sleep in yonder mill, amid the din and noise of its whirring machinery, and yet the miller is able to do so. But let one of the bearings become dry and make the slightest noise, a noise such that you and I would pay no attention to, yet it will awaken the miller, while the much greater noise to which he is accustomed would not in the least disturb or arouse him. Psychology, then, must also treat of all the sub-conscious activities and endeavor to explain them.

And then have you not noticed how the blind man feels with the end of his cane and how the wood-carver traces with the point of his chisel, just as you or I feel with our hands and fingers? Furthermore, have you not observed the professional mannerisms displayed by men of different avocations? You can generally pick out the lawyer, the physician, the clergyman, the business man, by these professional mannerisms, which settle upon one even before he is thirty.

And there is also the Psychology of prejudice. We like certain people better if they are Democrats or Republicans, Congregationalists or Baptists. A certain college in one of the States of the Central West catered to the prejudices of its constituency when its officers sought throughout the country for a professor of mathematics who should be at the same time a Methodist and a Democrat. The very hope of aristocracy, indeed of the "Four Hundred" itself, lies in the Psychology of prejudice. Some people will not fraternize with us unless we can boast of "blue blood," or are the burdened possessor of a "Van," or some other Hollandish or "outlandish" prefix. Suppose that for some whimsical, fanciful reason you have taken a dislike to some name, *e.g.*, Ethel, or Bridget, or Marie. When you meet a person bearing any one of these names you at first, perhaps unconsciously, form a dislike for the person herself. The Bostonian must live on Beacon street or Commonwealth avenue if he wishes to gain an *entrée* into a certain social "set." The Dartmouth student can never be quite so friendly with the man from Amherst as he can with the man from Williams. In fact, all sorts of clannishness finds its basis in the Psychology of prejudice.

I think now it is entirely clear that the scope of Psychology is very broad—that it touches every branch of our daily life and activity. And how much better is such Psychology than the narrow sort which restricts itself to the merely speculative form and discusses the faculties and "categories of thought" in a hazy, vague sort of way. But let us as students, if possible, enter this broad field before us without preconceived notions. I hope we have no cherished theories which we wish to substantiate. Let us first inquire into all the facts before framing our theories. "First describe, then explain," is ever the true order of the scientific procedure. Of all persons, the psychologist must have an unbiased mind. He must be thoroughly imbued with the spirit of investigation—the true scientific spirit. But when once he discovers that the facts support a certain principle, and that that principle alone is compatible with the discovered facts, then he is morally bound to adhere to a position that is in harmony with this established principle. The psychologist must have clear mental vision, with no cataract over the eye of judgment, and must have command of a wide range of thought. I have in my laboratory an instrument invented by Wheatstone, called the pseudoscope, in which the mirrors are so arranged that each eye sees the image which the other eye ought to see and would see under normal conditions. By means of this a solid object, as a pyramid, will appear hollow—and *vice versa*. From propositions advanced by certain would-be psychologists, who have had neither special training nor possess very great natural ability, it would seem that some sort of mental pseudoscope had been employed. At the close of his investigations the psychologist must have for his conclusions clearly established principles, in the light of which he may interpret new experiences as they arise. When these principles are clear-cut, definite and thoroughly established he must "hew to the line" and not vacillate to and fro, a mere rudderless bark moved about by the wind of other men's breath. He must settle all the more important questions of Psychology for himself, on an independent basis. When this is done we shall never become "hewers of wood or drawers of water" for any particular school of thinkers. With a clean, well-trained eye and the mind's "retinal field" cleared of all floating specks, the student of Psychology must ever seek for the truth, and the truth alone, if he would not be handicapped, for in this as in all other lines of investigation—"the Truth shall make you free."

LESSON III.

THE METHODS OF PSYCHOLOGY.

In the previous chapters we were occupied (1) in indicating the real service of Psychology to the average teacher, and (2) with the query, What is Psychology? which suggested some of the many questions with which the psychologist has to deal, thus giving us an idea of the province of Psychology in the realm of the sciences. We must now allude to some of the methods employed by the psychologists in order to learn just how they gain their conclusions; for, if we know the several methods thoroughly well, we will be able to decide which one is the best for our purpose, therefore the one we should employ as teachers in our own investigations into the many interesting mental phenomena that present themselves from day to day. An acquaintance with these methods is exceedingly important. We can never take a scientist's conclusions as valid unless he tells us how these conclusions were reached. We must know his *modus operandi* before we permit his deductions to pass muster. It is not sufficient for the astronomer to tell us that he has discovered a new star—he must tell us just how, and under what conditions he came to observe it, and is obliged to designate in mathematical terms the exact location it occupies in the heavens. The histologist may announce that in a particular portion of the brain he has observed certain peculiarly shaped nerve cells. Before this announcement is of any value at all, he must submit a detailed description, among other things, of the way in which the brain tissue was prepared for examination, stating what reagents were employed in hardening and staining the specimen, and the thickness of the sections he examined, as well as the kind of microscope and objective he used in his observations. In fact, all truly scientific work must be frank, open and "above board." Hypocrisy and deception are quickly discovered in the scientific field. A knowledge of methods is necessary before accepting conclusions.

You have noticed that all methods of investigation are becoming more and more exact. The scientific laboratory is quite a modern innovation. There was a time when about all the apparatus needed by the chemist consisted of a "spoon and a bottle." Even more recently has the physical laboratory been established with its essentially large, extensive, and indispensable equipment. And nearly all of us can remember the time when such a thing as a general biological laboratory was but little thought of and comparatively unknown, while special laboratories devoted to anatomy, physiology and bacteriology were not considered possibilities, but were regarded as phantasms of fanciful dreamers. Formerly all investigation took the speculative turn. In fact, they were not real *bona fide investigations* at all. The old scholastic philosophers were oftentimes busily engaged with utterly senseless questions, waxing warm, and hurling anathemas at each other, in their discussions with reference to the number of angels that could stand on the point of a cambric needle. Yet these same men, renowned for their learning, imprisoned and martyred others who sought by means of practical experiments to find a key with which they might be enabled to read the book of nature. Aristotle was the son of a renowned physician, and yet he knew of no function that could possibly be assigned to the brain, unless it be that of lubricating the eyes. The principle of life was discussed, and a "vital fluid" was resorted to as an explanation, but no one was permitted to study the living organism itself. The true scientific spirit, wherever it manifested itself and lifted up its voice of inquiry, was stifled, and the man who dared to experiment within the world of nature and delve into her secrets was soon proscribed by the church and disowned by his countrymen (who should have hailed him as a benefactor), and then hurried off to the dread inquisition—

"Theirs not to make reply
Theirs not to reason why
Theirs but to do and die."

But we have nothing of the kind at the present day. The scientific spirit is "in the air." It can never again be throttled. How glad we are that science studies are being introduced into all our schools; even if it is coming slowly, the era is near at hand when every child will be brought face to face with nature, and the purely mechanical, artificial methods of teaching will be abandoned for all time. You ought to felicitate yourselves as teachers that you live in this eventful and auspicious epoch at the beginning of a new era in education with its natural methods—its kindergartens, its science studies, its natural history and travel readers.

While it is very evident that the methods of all the other sciences have in these latter days assumed more and more the character of exactness, can the same be said of the science of Psychology? Is it a more exact science than formerly? Are its conclusions to-day more trustworthy than the metaphysical guesses of the old-time Psychology? You will say at once that you can easily see that the physicist is able to assiduously pursue exact methods and apply them to his subject-matter; that surely the histologist should have a trained eye, a good memory, superior powers of comparison and an excellent microscope; that it goes without question that the anatomist must make use of the scalpel and microtome; that the botanist and the bacteriologist should by all means have abundant laboratory facilities; that the astronomer is morally bound to use the largest available equipment, but you seriously question whether there can ever be any considerable exactness within the domain of psychological study. Many people question this, and are anxiously asking, How can Psychology be brought out from under the clouds of never-ending speculation, and be placed upon a solid basis, after the manner of the other sciences? Do the phenomena of mind admit of treatment by the modern inductive scientific method? Are there such things as mental facts, and can they be subjected to close analysis, well planned tests, ingeniously devised experiments and accurate measurement? These inquiries are often made, and being made seriously, are therefore entitled to the most respectful attention. But will you hold these questions "in solution" for a moment while we briefly pass in review the method or methods generally employed in lieu of the modern experimental methods of laboratory Psychology. When we see the insufficiency of these methods, in that there are many questions which they are wholly unable to solve, then we will be better prepared to outline the field and functions of the experimental and more scientific method. Remember that as psychological students we are seeking to discover what mind is, what it does, how and under what conditions it acts, and the laws according to which it unfolds and develops.

The method which is the oldest—the one that has been employed (though at times in a crude, crass way), ever since Psychology began to take form—is that of introspection, which signifies *looking into*, and the adjective, *introspective*, is the name given to the methods of that large group of psychologists who believe all the questions concerning mind can be answered by the mind undergoing a sort of rigorous self-examination. The introspective method is sometimes called the "subjective" method. This comes from the fact that the mind, as that which knows, thinks, feels, wills, and desires, is called the "subject" of the mental states in order to distinguish it from the "object," as that which is known or felt or affects the mind in any way. The tree I see, the river I delight in, the flower I admire, are *objects* to myself, who am the subject that admires them. By means of the subjective or introspective method, we look within and take an inventory of our thoughts and ideas just as the merchant takes stock of the goods in his store. By this method we direct our attention to what is going on in our own mind at the time of its occurrence or after it has taken place. We have no power of turning our attention inward and focusing upon the mental states themselves as they pass along the "stream of consciousness." Some psychologists, as Sully for example, say that we can attend to a certain particular feeling, such as emulation or sympathy, in order to see what its nature is, of what elementary parts it consists, and how it is induced. This is true only to a certain extent, for the great difficulty of the subjective method is that a mental fact vanishes as soon as you begin to examine it introspectively. Suppose you are at the theater and the play is a melodrama. There are touches of sadness which call forth deep emotions and bring tears to your eyes. Attend closely to the feeling with a view to noting its constituent elements and it vanishes. The next time you are thoroughly angry make use of the introspective method and focus your attention "in order to see what its nature is, and of what elementary parts it consists," and at once your muscles begin to relax, your teeth are not set quite so firmly, your fist is no longer so tightly clenched, and before you are aware of it, you are in a perfectly placid state, with no emotion of anger to analyze. On the other hand, as you well know, a sensation of pain when closely attended to becomes more intense. Take it all in all, you are in something of the same position as the entomologist, who, as he attempts to examine a small living insect under the microscope, finds that it is always crawling away from the objective and getting out of focus. If a flower that the botanist has in his hand were to vanish the moment he began to examine it closely, he would meet a difficulty quite analogous to that of the student of mind using the introspective method. In fact, a psychologist in his endeavor to "catch up" with his mental states in order to examine them more closely, is like a greyhound trying to outrun his own shadow, for the mental facts disappear the moment he seeks to examine them—he has the deliverances of memory as his only data; in fact, "his introspection becomes retrospection." Certain it is, that errors of the purely introspective method—and there are many bald errors arising from the deranging effects of close, scrutinizing attention—can only be remedied by an appeal to memory. Like the cerebral anatomist, the purely introspective psychologist must examine "dead tissue" instead of the living organism, and as dead tissue is widely different from living tissue, so a mental state is sadly distorted when viewed in retrospect. Mental states that are always escaping direct examination may be reproduced in the form of memory images, and in this way be analyzed.

Far be it from me to deny the utility and value of the introspective method, and yet no one can help but see that, good as it is, it has many limitations. There are many questions in Psychology which are raised by the introspective method which it cannot answer of itself, and cannot be answered but by appeal to experiment and the external aids. To begin with, the introspective method inverts the order of actual experience and mind development. Reflection is not attained until the higher mental powers are mature, and by it alone there can be no knowledge gained with reference to the rise and growth of the intellectual powers in childhood. Child-study, the most fruitful line of investigation for the teacher, can find no *raison d'être*, if Psychology be restricted to the introspective method. And then, if this subjective method alone be used, the science becomes purely descriptive. Now, the fact is, that science demands *explanations, causes and sufficient reasons* more than descriptions.

How then, you ask, can the introspective method be best supplemented in order that Psychology may become more useful to the teacher? The subjective method represents but a half truth and must be supplemented by an appeal to what we shall designate in a general way as the *objective* method, in order that the whole sphere of psychological truth may be ours. Rather we should say objective *methods*, for we mean to signify by this term all those ways of studying mental phenomena, aside from the scrutinizing self-examination which occurs when we "take stock" of the ideas and thoughts of our own individual minds. One form which this objective method takes is the study of the minds of others who are of "like passions as we are," that is, belong to the same order of society. In this we reason by analogy. We note the looks, gestures, bodily posture of others, and we conclude these are manifestations of feelings similar to those we ourselves often experience. I give the boy a new, gaily-colored kite; his countenance brightens up, he becomes so demonstrative that he can hardly contain himself, and I say he is *grateful* because I acted in the same manner under the same circumstances when I was a boy. After a few hours I see him again. His face has a woe-begone expression, quite different from the joyous countenance with which he left me. Tears following the lines of least resistance, have made valleys on his begrimed face, and as he comes sobbing to me I pity him, and say he is suffering acutely *just as you or I suffered* when years ago our kites landed in treetops or became entangled in the telegraph wires. If at a public gathering you see a person sitting back in his chair, his legs extended at full length, his arms hanging limply at his side and his head resting against a convenient pillar, you conclude that he is not so deeply interested as the listener who sits bolt upright in his seat, or leans slightly forward and has his eyes riveted upon the speaker. By means of such outer signs as these we are enabled to determine the mental states of others. We proceed on the principle that mind, in a general way, is the same in all persons.

If a certain object produces in one the sensation of red, and another object produces the sensation of heat, and another the sensation of taste, and still another arouses the feeling of intense pity, I argue that they would produce similar sensations in another person. We feel warranted in taking the manifestations of others at their "face" value, and we interpret them in the light of the facts of our own experience. As teachers you must do this continually. Of course, the minds that are the most important for you to study are the minds of children under your immediate direction, and you must and can study them only in light of your own experiences. To succeed as a teacher you must know what is passing through their minds, and this you can gain only by observation of countless external signs. You must notice their amusements and games, the kind of books they enjoy reading, the manner in which they take punishment, the studies they delight in and those they detest; whether their sensations are keen or obtuse, whether their memories are good or bad; in fact, you must notice everything that will help you to know the nature of their minds. In another chapter I shall outline for you certain tests that every teacher may employ in any schoolroom—tests that will enable the teacher to discern the exact stage of development his pupils may have attained along any special line; for example, his powers of observation, memory and attention. And as you interpret the experience of those living minds with which you are in daily contact, you must also interpret the character of men who have lived years agone. You must gather all the facts you can about Napoleon, from every available source, and thus get the truest possible picture of his mind and its activities, before you are in the least degree able to interpret the historical events in which he played so important a part. When I desire to clearly understand the rites and orgies of the savage tribes I must, with the aid of the imagination, orientate myself into their experiences as nearly as possible in order to understand the significance of these experiences. Cannibalism is quite inconceivable until, by investigation and inquiry, we gain the point of view of the savage himself, and then we discover that it is in obedience to a religious impulse rather than a physical appetite, that he commits his revolting crime. From the standpoint of an American mother, it is impossible to conceive how the Hindoo woman can throw her infant into the Ganges. To understand this seemingly cruel action, we must know the mental operations of the mind of the Hindoo mother. Could you but know the mental make-up of Benedict Arnold you would have more charity for him, and would paint his traitorous deed in kindlier colors. We must as nearly as possible place ourselves in the same position as others, both as to surrounding conditions and temperament, in order to understand the actions that have caused them to be remembered in history. When you tell your school children how the great and immortal Lincoln behaved toward soldiers sentenced to be shot, they say he was a man with a big sympathetic heart, just as if they had seen him and known him all their lives. The school boy enthuses over William Tell, and admires his sturdy qualities just as if he were a real, historical character, instead of a fictitious personage. In exploring an Aztec treasure house we gain an idea of the mental life of this prehistoric people — as true a picture, so far as it goes — as if they lived and moved and had their being at the present time. Thus you see that whatever you learn concerning the mind of others you learn by means of the objective method in one of its phases.

Another invaluable form which the objective method takes, gives us what is known as "animal" or "comparative" Psychology. The study of animals is of the utmost importance to the psychologist. The study of the mental life of animals is as important to human Psychology as the study of comparative anatomy is to human physiology. The mental states of animals are simpler than those of man, and are therefore easier to treat than the more complex processes of our adult mental life. Many forms of memory, for example, are in certain animals much better developed than in man. We also have some few emotional experiences in common, such as fear and the like. You are in a carriage driving a lazy horse and take the whip from the socket; he hears you do so and starts on at a lively gait. Is the mental process in this case unlike that which goes on in the mind of a boy who is doing some overt act *sub rosa*, oblivious of having been discovered by the teacher, until he hears her reach for the ferrule, when, quick as a flash, he straightens up, his face assuming a serious and studious air as he becomes deeply engrossed in his studies for the time being?

I remember, when yet a boy, of strolling one morning along the banks of White River at Indianapolis. Soon I noticed that a blind horse had wandered into the river, and, getting beyond his depth, was in danger of drowning, for he could not tell in which direction the shore lay. Men planning to save him were seeking for boats and a rope with which to go to his rescue. At this juncture a saddle horse which had been left standing in front of a store near the bank, having heard the piteous sounds of the blind horse, galloped to the water's edge, and then swam to the bewildered and struggling animal, taking hold of the mane with his teeth, led the sinking horse to the opposite bank where it was easier to land than at the one whence he had come. This seems to me a mental process very akin to reasoning in man.

The mental states of animals are more naive and not so interrelated and complex as our own, and can therefore be traced to their origin and sources much better and more readily than is possible with our own activities.

But even more important than animal Psychology is the study of infants. The significance of the important facts gained by the study of mind in its earliest stages has already been insisted upon. By means of infant Psychology, mental facts are reached as far as they ever can be, in their simplest, most primitive and original form. You must know what the mind is before you can know what it becomes. You must know its actualities before you can know its possibilities. The growing child is continually giving us object lessons in the development of mind. And do you not know that every great educational reform has been the direct result of close personal relations with children and youth, and more thoroughgoing insight into their needs, experiences and modes of thought and feeling? The greatest teachers of the world have actually *lived* with their child pupils, and studied them continually. Froebel recommended that when a child was born, each parent should open a life-book in which should be recorded the stages of its physical and mental growth, good and bad influences and qualities; all striking incidents, experiences and peculiarities; and their own endeavors and motives in rearing the child. This book should be kept without the child's knowledge, to be given him at maturity as a guide to aid him in his choice of a profession or calling.

A sound knowledge of the early manifestations of mind is a necessary prerequisite for the scientific explanation and interpretation of later mental development. In the matter of child study the psychologist is dependent upon the special educators of the young, both teachers and parents, and from them he does receive much valuable aid. There is much that can be done by parents in the way of recording the course of development of individual children. The work already done in this line by Dr. Preyer and M. Perez with reference to the first three years of childhood, is stimulating and suggestive. Every school-teacher, to be worthy of his place, should be eager to compile statistics, especially with reference to the times at which certain faculties manifest themselves. In so doing he would magnify his office in the best sense, for he would place every psychologist under obligation to him, because of the valuable fund of facts supplied. Whatever you may think of this, certain it is that there never has been a period when careful, painstaking study of the nature of children was so much needed as now, and nowhere so much as in our own country. Small beginnings, however, have already been made, and scientific child study is making most hopeful progress.

The most important development of the objective method of psychological investigation finds its expression in what is usually called "laboratory" or "experimental" Psychology. I shall not stop at this juncture to argue with reference to the necessity of well-selected apparatus to the psychologist. I will state, however, that there are some of the most weighty questions of Psychology which were thrown overboard by the introspective school as unanswerable, that have been answered by experimental Psychology alone. And this is a most remarkable fact when you recall that twenty years ago there was no such thing as a psychological laboratory. Until very recently, the psychologist was compelled to gain his material and especially the leading facts concerning sensation, from among the crumbs that fell from the tables of neurology and physiology. The first laboratory was founded at Leipzig in 1878, by William Wundt. From this little workshop went forth an influence that has been gaining in strength and volume each succeeding year. The leading German universities all have psychological laboratories more or less pretentious, the best being at Leipzig, Freiburg, Göttingen and Bonn, while Heidelberg, Berlin and Munich have made excellent beginnings. There are also good laboratories at Prague, Rome, Geneva, Copenhagen, Paris and Gröningen. In this country the first beginnings were made in 1885 by G. Stanley Hall and Dr. Cattell, at Johns Hopkins University. The University of Pennsylvania soon followed suit. We now have at this writing sixteen laboratories in this country with an equipment of apparatus valued at $40,000, which is devoted entirely to psychological investigations. Harvard has the one largest and best equipped, with Clark University a close second. Yale has just begun its work in this line and Columbia is among the very best in this as she is in other fields of investigation. Cornell has a large endowment for this especial purpose and a magnificent equipment of apparatus. The University of Indiana has excellent facilities and offers good courses in this line. Likewise Wisconsin and Chicago Universities. The movement has gained a good foothold in the State University of Iowa and also that of Nebraska. Brown University has a model laboratory, and Stanford University with its unlimited resources has an equipment very hard to excel. The Catholic University at Washington has shown an admirable spirit of progression in providing so liberally for such a laboratory. The University of Illinois, located at Champaign, has also a special laboratory for psychological investigations, which is devoted particularly to the study of those departments of child study that will furnish results of the greatest value to the common school-teacher. These things are mentioned merely to show that the *exact methods* of the laboratory as applied to Psychology have gained a strong foothold in the institutions of our great American commonwealth. We hope it may prove a mustard seed of inextinguishable vitality.

But what are some of the problems that this department of Psychology has to solve? These problems can, I think, be best indicated by an allusion to the different groups of apparatus employed:

I. Apparatus used to represent the brain, nerves and organs of sense (such as the eye, ear, tactile corpuscles and taste bulbs), illustrating the intimate connection between mind and body, as well as the physical basis of the psychical activities.

II. Apparatus used to investigate the Psychology of the senses. This is the largest group, but the apparatus is comparatively inexpensive. Color mixers of various types, prisms, apparatus for after images and color blindness (used in testing accuracy of color perception), as well as a dark room, are needed for experimenting upon the visual sense. Also a full equipment for experiments upon the senses of hearing, temperature, touch, taste, smell, rotation, effort, etc., is essential.

III. An expensive but absolutely indispensable collection of instruments used in the time measurement of mental processes, from the very simplest psychical acts to the more complicated forms of comparison and association. These useful instruments serve a function to the psychologist similar to that supplied to the anatomist by the micrometer eye-piece. He measures the thousandth part of a millimeter—the psychologist with his chronoscope measures the ten thousandth part of a second.

IV. A complicated group of apparatus for the investigation of the higher mental processes, such as attention, memory, perception of time, position and distance.

V. There must also be a set of devices for the purpose of investigating the nature and content of the child's mind at the various stages of its development. This gives an indication of the immense service experimental Psychology can render to pedagogy. Experimental Psychology has justified itself in offering a sure and exact method of investigation into the child's mind with a view to ascertaining the best path of development rather than longer traveling along the hard-beaten roads of traditional educational customs. If the teacher will but make use of the facts and conclusions of the never-failing "new" Psychology, he will be enabled to give the world, for each pupil sent to his school, a rounded out, well developed citizen—one in whom "the length, breadth and height thereof are equal."

I have but meagerly indicated the methods and functions of the various objective forms which Psychology must take in order to successfully deal with the facts of mental life.*

It will be seen that the old introspective method when used alone is unsatisfactory, because it leads Psychology to become more and more speculative, impractical and visionary. As simple observation cannot suffice for the science of physics, it cannot possibly suffice for the science of Psychology. *Observations*

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*For an excellent and most valuable detailed statement, see A LABORATORY COURSE IN PSYCHOLOGY, by Prof. E. C. Sanford.

in Psychology, as in other sciences, must be confirmed and modified by experiment. Psychology must be treated as a natural science. The old speculative Psychology has been abandoned by those whose methods of thought are scientific, and empirical Psychology has taken its place. And this is the correct thing, for *Psychology is really a science of fact and its questions are questions of fact*, and the psychologist must treat theories and hypotheses as rigorously and with the same impartial criticism as is demanded in other departments of research. The old Psychology in its speculative form was incomplete and failed because it ignored the body. The new Psychology cannot afford to ignore the subject of mental states. But Psychology which is purely introspective in its nature must ever be sterile; and no wonder is it that, in some quarters, Psychology has borne the reputation of being the driest and least interesting of all the sciences. Furthermore, it is certainly true that exclusive attention to the contents of our own individual minds can never give us a general knowledge of mind. In order to relieve our methods of these defects we must at every stage of inquiry compare our own thoughts, ideas and feelings with those of other minds, even if it should result in the removal of some of those "ancient landmarks which our fathers have set." The true Psychology will ignore neither the facts gained by introspection nor those supplied by the objective method, but gathers from every possible source the established facts of mind. When you study physical science you observe physical phenomena and work up by careful methods of procedure to physical laws; so in your study of the science of mind you must begin with the simplest mental facts and work up to the general laws of mind. Psychology then is under obligation to study every sort of mental activity by the inductive process, and then submit these discovered facts of the conscious life to rigorous and systematic treatment. As the outcome of this painstaking research we will be able to see clearly that the mind is a real unit being, non-material in its nature, unfolding and developing according to certain laws of its own.

LESSON IV.

THE CONNECTION BETWEEN BODY AND MIND.

From the very earliest times it has been recognized that an intimate interrelation obtains between mind and body. Alcohol in some of its forms, tobacco, coffee, opium, and many other drugs have been used for ages for their supposed mental effects. These vague notions have been borne out by numberless scientific investigations of the past few years. These scientific observations are rendering more precise and extending the application of what has always been known in the commonest experiences of man. It is an indisputable fact that mind and body are closely related, and that each modifies the activities of the other. It is a dictum of psychological science that mental facts can never be properly studied apart from the bodily conditions and physical environment amid which they take place. On the other hand, all mental states are followed by bodily activity of some sort. Thus, you see, the relation between mind and body is a reciprocal one—*mind affects body and body influences mind.* I do not wish you to take this statement "on faith" at all; on the other hand, I very much prefer that you draw your own inferences after a survey of the following facts.

You well know that if the amount of the blood supply is in any way interfered with, modifications of the mental processes are certain to take place. Notice, for example, the sudden rushing of blood to the head. In such a condition total unconsciousness frequently results. And then strong coffee will keep some people awake because its stimulating qualities cause the blood to circulate more freely over the brain, and increased mental activity results, which is too intense to be inhibited in order that sleep may ensue. Of the greatest importance, then, is the *quality* of the blood supply. The quality of the blood may be impure from some error in the processes of digestion, assimilation or excretion. To take the common instance of dyspepsia or even ordinary indigestion, we find that such disorders are invariably followed by melancholia or at least by a bad temper. The presence of bile in the blood even in healthy, strong individuals gives rise to gloomy forebodings and a feeling of "blueness." The presence of uric acid in the blood of a gouty patient causes an irritability of temper which at times is so severe as to make him for the time being a maniac. Knowing, as we do, the effect of certain drugs, such as chloroform producing anesthesia, nitrous oxide gas producing laughter and alcohol causing hilarity and excitement, we are forced to admit that the mental processes are affected by changes in the quality of the blood from which the brain receives its nutrition. And then, consider the delirium of fevers. The poisons present in the blood in febrile diseases gives rise to confusion of the mental states. The delirium which is present in typhoid fever is different from the delirium which is manifested in rheumatic fever. The insanity which results from influenza, or "*la grippe*," is very different from other post-febrile insanities. The child, and, for that matter, you yourself can think better if the head is rested upon the hand or the forehead rubbed with the fingers. The posture of the body plays an exceedingly important function in its relation to the mental processes. You cannot imagine an angry man with his arms hanging loosely at his side, with his fingers spread apart, and his muscles relaxed. No, indeed; the angry man stiffens every muscle, clenches his fist and sets his teeth firmly. A person can never conduct an argument when languidly sitting in a chair; he must lean forward or stand up and throw his arms about, or indulge in other gestures equally emphatic.

And in this same connection, I am reminded to speak of the effect of tobacco upon the mental processes. Of course these disturbances are much more pronounced in the case of the young growing person than in that of the confirmed smoker. It is not within my province to speak of the physiological disturbances due to the two poisons, nicotine and pyridine, which tobacco always contains. I shall not speak of the especial diseases of smokers, nor of the particular disorders which afflict the laborers in tobacco manufactories. I only desire, in passing, to refer to the mental disorders which result from the use of tobacco, especially on the part of the young, such as hallucinations of vision, anxiety, loss of memory and general mental depression. You will find an interesting commentary on this point by referring to the investigations made a couple of years ago upon the students of Yale College, where it was found to be true beyond a possibility of contradiction that "tobacco inhibits the physical growth, and causes a loss of mental power in those addicted to its use." The vigorous action that college students themselves have taken in this matter is more potent for good results than anything that any "old fogy" outsider could say or do. I refer to the well-known fact that no body of college students will give a place on any of the athletic teams, be it the foot-ball eleven, the base ball nine, the boat crew, or in track athletics, to a man who uses tobacco in any form. And as any observer of college sports will tell you, this is not because it injures muscle alone. Men whose only recommendation is their muscle are not the ones who gain a place on the athletic teams, for it is very evident that the "heady" player is the one most in demand, and college games are won by "gray matter" rather than beefy tissue; by means of brain rather than brawn.

Attention ought also be called to the connection of the bodily condition with the phenomena of memory. Ribot and others have shown that in a general way reproduction of impressions seems to depend upon the circulation of the blood, especially in the brain. Related to this is the familiar fact that bodily injury will disturb the memory, as the case reported by Dr. Winslow so well illustrates: "A clergyman of rare talent and energy, of sound education, was thrown from his carriage and received a violent concussion of the brain. For several days he remained utterly unconscious, and when restored his intellect was observed to be in a state similar to that of a naturally intelligent child. Although in middle life, he re-commenced his English and classical studies under tutors, and was progressing satisfactorily, when, after several months successful study, his memory gradually returned, and his mind resumed all its wonted vigor and its former wealth and polish of culture."

Actual experiments with reference to the influence of drugs, stimulants and narcotics upon the psychical processes have been undertaken, and with some interesting facts well established as a result. During the fall of 1891, I was located at Freiburg, Germany, where Professor Münsterberg's excellent laboratory was then in operation. While there I took part in some interesting experiments in this very line. The description of these experiments with their results has recently been published in Germany; but I shall give you in brief outline an account of the methods employed and the facts gained as conclusions. As stated above, these experiments were for the purpose of determining the influence of certain materials upon the psychical processes. Three groups of substances were used. In the first group tea, coffee and alcohol in various forms (beer, Rhine wine, Bordeaux red wine and brandy) are included; while the second embraces opium and sodium bromide; and the third quinine, anti-pyrine and phenacetine. Medium doses only were given so that no possible danger could ensue. The various psychical processes upon which the effects of these different substances were tried, were four in number (1) the memory of certain figures, letters and sounds (similar to the test I outline in my chapter on memory); (2) the simple addition of numbers; (3) the naming of colors; (4) the counting of letters on a printed page. The effect of the different nervines was tested at regular intervals for two hours after partaking of them. I will first take up the simplest of the experiments, viz., the counting of letters on a printed page. The problem was merely to count the greatest number possible in a given time—two minutes. I shall designate the four persons taking part in the experiment as A, B, C, and D. The experiments were tried at three different intervals (one-quarter of an hour, one hour, wo hours) after partaking of the alcohol, drugs, etc. The shown more clearly in the following tables; the sign +, before a number means that so many letters more, and the sign —, that so many letters less could be counted under the different influences, in two minutes, than in the normal condition—*i. e.*, without having partaken of the various nervines.

Table showing number of printed letters, more or less, that could be counted in two minutes after partaking of liquors indicated:

Person.	Agent.	¼ hour after partaking.	1 hour after partaking.	2 hours after partaking.
A Normal record 406 letters.	Beer	—74	—23	+36
	Brandy	—67	—47	—20
	Rhine wine	—40	—12	+14
	Bordeaux	— 8	+20	+52
B Normal record 390 letters.	Beer	—60	— 2	+51
	Brandy	+ 5	+36	+53
	Rhine wine	— 8	+20	+36
	Bordeaux	+ 2	+26	+26
C Normal record 472 letters.	Beer	—45	—30	+ 3
	Brandy	—21	—11	—11
	Rhine wine	—70	—23	—27
	Bordeaux	— 4	0	+24
D Normal record 454 letters.	Beer	—22	+20	+48
	Brandy	—56	+12	+26
	Rhine wine	—24	— 2	+14
	Bordeaux	— 2	— 7	+15

The effect of tea in this experiment (counting printed letters) is quite remarkable. These are, of course, to be compared with the normal records given in the preceding table:

Persons.	¼ hour after.	1 hour after.	2 hours after.
A	+ 4	+27	+ 32
B	—16	+71	+100
C	0	+22	+ 43
D	+12	+20	— 15

Coffee has a similar effect in assisting this simple mental process, but the accelerating influence is not nearly so pronounced as in the case of tea.

The effect of drugs is clearly shown in the following table. As in the other tables + or − signs indicate the number of letters more or less than the normal record that the person could count in two minutes after having partaken of the drugs:

Person.	Drugs.	¼ hour after partaking.	1 hour after partaking.	2 hours after partaking.
A Normal record 406 letters.	Antipyrine...	−20	−17	−32
	Quinine......	−36	−27	+21
	Phenacetine .	+40	+52	+60
B Normal record 390 letters.	Antipyrine...	−16	−29	−24
	Quinine......	−12	+15	+35
	Phenacetine .	− 5	+20	+27
C Normal record 472 letters.	Antipyrine...	−38	−45	−35
	Quinine......	−40	−30	− 2
	Phenacetine .	+ 6	+ 6	+14
D Normal record 454 letters.	Antipyrine...	−80	−72	−56
	Quinine......	−25	0	+ 8
	Phenacetine .	+ 7	+ 3	+12

You can readily see that the most harmful of the three is antipyrine, and that phanacetine is by long odds the most beneficial. The depression of the psychical processes after taking antipyrine was so constant that one is tempted to give warning against the use of such a remedy (?) whose disturbing effects are so far-reaching and thoroughgoing. Similar effects follow upon partaking of even small doses of opium and sodium bromide.

I shall refer to only one other set of experiments that go to
ow the influence of these nervines upon the mental processes.
s in simple addition where there was a single column of ten
(1 and 0 being left out) to be added, and the time occu-
measured in hundredths of a second. The following
n sure, explain itself:

Person.	Agent.	Number of $\frac{1}{100}$ seconds longer or shorter ¼ hour after.	Number of $\frac{1}{100}$ seconds longer or shorter 1 hour after.
A Normal record 6.02 sec.	Beer	−0.30	−0.53
	Cognac	−1.49	−1.87
	White wine	−0.10	−0.14
	Red wine	−0.12	−0.68
B Normal record 7.56 sec.	Beer	+0.92	+1.10
	Cognac	+0.42	+2.34
	White wine	+0.62	+0.87
	Red wine	+0.73	+0.48
C Normal record 5.26 sec.	Beer	−0.21	−0.66
	Cognac	−0.09	+0.25
	White wine	−0.15	−0.83
	Red wine	−0.19	−0.29
D Normal record 6.72 sec.	Beer	+0.91	+0.42
	Cognac	+0.15	+1.02
	White wine	+0.53	+0.42
	Red wine	+0.81	+0.65

You will readily see that almost without exception A and C could add the single column of ten figures more quickly, while B and D had to take a longer time for the same work, after partaking of these alcoholic beverages. Both tea and coffee were found to be great aids to mental quickness in performing this simple arithmetical process. I have given you so many of these tabulated results because I am anxious that you see for yourself that the mental processes are always modified by the use of the common nervines—either helped or hindered, either accelerated or retarded. If these exceedingly simple mental activities are so perceptibly affected by these various agents, what great changes can be wrought by them in the more complex mental activities of comparison, association, reflection and reasoning.

But you will perhaps say "I readily concede that the bodily condition may affect the mind, but you have as yet given no evidence that the mind in any way influences and modifies the bodily conditions." Well, then, let us observe the following. I told

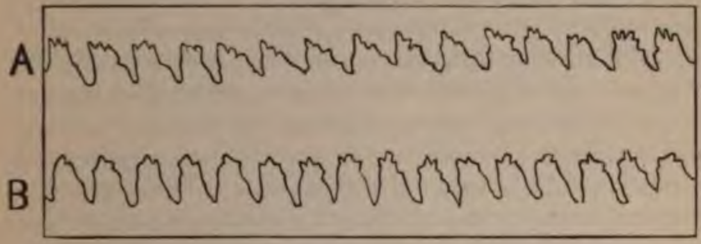
you in one place that indigestion and dyspepsia will cause irritability of temper and melancholia. It is just as true that melancholia will cause loss of appetite and indigestion. The person who is deeply grieving cannot eat, try he ever so hard. Notice also the outburst of tears or the "lump in the throat" caused by intense grief or sorrow. Mental excitement or anxiety affect the heart beats and the circulation of the blood. A violent emotion inhibits the circulation and so causes fainting. Great dread may prevent the secretion of saliva, a circumstance which lay at the basis of the old-time "ordeal of God" in which the accused person would be held guilty if he could hold rice in his mouth without wetting it. Fear will make one's hair stand on end. I know of no better statement of the bodily changes induced by fear than that of Darwin, which I quote at considerable length, because it so well illustrates the general points under discussion. "In fear, the eyes and mouth are widely opened and the eyebrows raised. The frightened man at first stands like a statue, motionless and breathless, or crouches down as if instinctively to escape observation. The heart beats quickly and violently so that it palpitates or knocks against the ribs; but it is very doubtful if it then acts more efficiently than usual, so as to send a greater supply of blood to all parts of the body, for the skin instantly becomes pale as during incipient faintness. That the skin is much affected under the sense of great fear is shown in the marvelous manner in which perspiration exudes from it. This exudation is all the more remarkable as the surface is then cold, and hence the term 'a cold sweat.' The hairs on the skin also stand erect and the superficial muscles shiver. In connection with the disturbed action of the heart the breathing is hurried. The salivary glands act imperfectly, the mouth becomes dry and is often opened and
shut. I have also noticed that under slight fear there is a strong
dency to yawn. One of the best marked symptoms is the
mbling of all the muscles of the body, and this is often first
n in the lips. From this cause and from the dryness of the
uth, the voice becomes husky and indistinct and may alto-
er fail. As fear increases into an agony of terror, we behold,

as under all violent emotions, diversified results. The heart beats wildly, or fails to act and faintness ensues; there is a death-like pallor, the breathing is labored, the wings of the nostrils are widely dilated, there is a gasping and convulsive motion of the lips, a tremor on the hollow cheek, a gulping and catching of the throat, the uncovered and protruding eyeballs are fixed on the object of terror, or they may roll restlessly from side to side. The pupils are said to be enormously dilated. All the muscles of the body may become rigid or may be thrown into convulsive movements. The hands are alternately clenched and opened, often with a twitching movement. The arms may be protruded as if to avert some dreadful danger, or may be thrown wildly over the head. In other cases there is a sudden and uncontrollable tendency to headlong flight; and so strong is this that the boldest soldiers may be seized with a sudden panic." "Trembling with fear," an "aching heart," "shuddering with terror," are not mere figurative expressions by any means. Mental fatigue will induce bodily fatigue. A few weeks ago I made some experiments that demonstrate this very clearly. The experiments were performed upon fifty grammar school children who were about to take an examination in general history. Before they took the examination I had each one endeavor to lift with the dynamometer all he could with his right hand (all the pupils were right-handed). I then put down the records for each pupil. After their examination (which lasted 2½ hours) with its severe mental strain, I had them do the same thing again, that is—lift their best. They were all, with two exceptions, unable to lift as much as they had before entering upon the intense mental activity of the examination.

Then, too prolonged mental exercise draws off the blood from the rest of the body in too large quantities, in order to supply the demands of the wearied brain. Thus a nervous, excited, brain-weary person always suffers from cold feet and fingers. After these persons fall asleep, when the demands for blood on the part of the brain are not so great, the mind being less active, the extremities again become warm. Mental activity always causes a rise of temperature in the brain. Over eighty localities on the brain have been examined with regard to the effect of intellectual work on its temperature, and every space thus examined has shown that an actual rise of temperature followed each mental exertion. In right-handed persons the rise of temperature is greater on the left side of the brain, and in left-handed persons the rise of temperature is greater on the right side of the brain. This is because of the fact that right-handed persons are all left brained and all left-handed persons are right-brained—due to the fact that the fibers cross at the base of the brain, as I shall make clear to you in the lesson on "The Brain and its Functions." Not long ago I myself undertook some interesting experiments with reference to the effect of mental activity upon the temperature of the brain. The experiments were made upon living dogs. I inserted thermometric needles into the substance of their brains. After a few hours of rest and sleep I tested the animals by means of exciting the various senses. For example, I held a piece of meat to the dog's nose, and, as soon as he smelled of it, the thermometric needle indicated a rise of temperature amounting to a little less than one degree. When I called to it playfully, there were similar results in the way of rise in temperature. This shows that the activity induced by stimulating the different senses actually heated the brain mass itself. Mosso's observations on three persons whose brains had been laid bare by injury to the skull gives us the best direct evidence of the fact that mental activity, either intellectual or emotional, causes a sudden rush of blood to the brain, increasing the heat thereof. I should like to have you notice the tracing herewith appended, that was made with Mosso's Sphygmograph. By means of this little instrument the pulse beats are recorded in the form of tracings on smoked paper.

The tracing, A (see opposite page), was made by the pulse during intellectual activity, while B was made by the pulse during mental repose. Each sort of mental activity produces its own rticular pulse tracing. You get a different tracing when the d is occupied in adding numbers from what you get when the mind is engaged in interpreting the difficult passages of a scientific work.

This intimate causal relation between body and mind shows itself again with reference to the special question as to the connection between mental effort and one's diet. While you cannot measure the activities of thought in terms of beef and bread, you are more than warranted in maintaining that a strong rich mind cannot be the tenant of a poorly-fed body. I know that there are some isolated chapters in history which abound in sentimental gush concerning this or that eminent writer and thinker who lived in an attic, subsisting on little besides cold potatoes. If such statements are ever authenticated, they will certainly prove very rare exceptions; and even if it be true that these men could do a considerable amount of mental work on a diet of cold potatoes and white beans, we are still led to inquire as to whether or no these particular men could not have done a great deal more work and lived longer had they varied their rations occasionally, or even semi-occasionally, with porter-house steak. It is a dictum of mental as well as physical hygiene that it is far better to stint one's self along any other line rather than deprive ourselves of food of needed quality and quantity. I say *stint*, for it is *not* economy. Poor food means poor blood and not enough of it, and this in turn means a brain starving for oxygen. Such a brain is always a weary brain, slow to respond and erratic in its activities; and this fatigued, poisoned brain can never sustain mental processes of high character or strict integrity. Therefore, I say, that in treating of the reciprocal



influence that obtains between body and mind, the question of diet is one of special importance to those having the care of children, and should be discussed at great length by educators in order that it may receive in every quarter the attention it so richly deserves. A locomotive, capable of drawing a train of 1,000 tons one mile in three minutes cannot make the same time with a heavier load. It is manifestly impossible. So in the case of the child, a given task requires a certain amount of brain energy, and without sufficient physical nourishment to sustain the brain, the task must be more or less incomplete. Almost universally wrong impressions prevail as to the proper nourishment of children. As a rule they are *underfed.* Too little variety is given them, while the food lacks the nourishing qualities which the child's system demands. It would seem to most mothers an absurd rule to lay down for their guidance that children should be given whatever their appetite demands. Yet, if the natural cravings of a child's appetite have always been satisfied, the most judicious mother need not fear yielding to its request. Let us go slightly outside of our province and look a little more carefully into the physiological side of the question in the way Herbert Spencer so excellently presents it, and I think we may answer some of the objections which my statement may have aroused. What does a child ask for most frequently? Sweets, you say, candy or sugar; fruits, possibly unripe preferred, meats, etc. Any physiology will tell you that sugar is a necessary element to the vital processes, and that many other compounds are converted within the body into that very sugar which the system demands as a heat making power. Almost as universally, children dislike fatty food, which is another heat maker; so an extra amount of saccharine matter is called for in order to produce the required heat. The craving for fruit is a normal one, and the acids of fruit form a natural and healthful tonic when taken in moderation. It is the fact that these kinds of food are denied them, and that this craving is so long repressed, that leads to the immoderate indulgence of the appetite when the usual restraints are removed. Then the question of giving children the full allowance of meat is a disputed one. In many cases economy suggests that "very much meat is not good for little boys and girls," and this statement has largely come to be regarded as a gastronomical fact. Reliable statistics have already proven conclusively that the child brought up on a bread and potato diet lacks that physical strength and activity, even though the weight and size be equal, which the meat-fed child possesses. This does not apply to the very young child, but to those beyond the age of three who manifest considerable vigor. Even more than adults in proportion to their size they need strengthening food, so that not only the daily waste may be supplied, but the extra nourishment demanded for growth may also be furnished in abundance, if full and healthy development is to be attained.

Another usually faulty point in children's diet is its monotony —too little variety, essential to secure the needed elements, is given. The child's weariness of a cereal food for breakfast, or a bread-and-milk supper, suggests that a different variety of food is demanded in order to meet the needs of the system, and the distaste for the customary articles of food is not a meaningless "freak of appetite." The required amount of brain energy can of course be supplied by a greater quantity of less nourishing food, but economy of the forces of the stomach would require that the food supply be a less quantity of the most nourishing substances, rather than a greater quantity of those containing less nutriment.

As good digestion is an aid to cheerfulness, so cheerfulness always induces good digestion. How important is it, then, that the child under your care be kept in a happy frame of mind. "Laugh and grow fat" is not a meaningless jumble of words, and this common go-to-mill expression may seem crude, but it really indicates something that should be a tenet of psychological doctrine, incorporated as a part of the "creed" of every individual. Besides, the habits of mind surely mold the bodily form just as single thoughts cause the facial expression to change temporarily. The animal expression, the beefy neck, the bleared eyes, and other characteristics of the dissipated, are not alone *physical* effects of the indulgence in alcohol or the gratification of the lower appetites. No, indeed; *the habits of thinking continually upon these fleshly indulgences and vices plays a very prominent part in thus permanently modifying the contour of the head and face.*

I need not go further into this question of the reciprocal action of mind and body. I simply submit to you such facts as those above given. They are only a few of the large number that might be adduced, and I am sure that each one of you could supplement these that I have given with many, even more interesting, from your large fund of observation and experience.

LESSON V.

THE NERVOUS SYSTEM.

An inanimate thing never responds to external impressions. If you handle a piece of iron, a slab of marble or a lump of coal there is no movement by way of answer to your touch. These and all other inanimate objects are utterly incapable of responding in any active or visible manner, either to natural changes in the environment or to modifications brought about by the hand of man. However, in the world of animate things, even among the very lowest forms, we observe a marked difference. We know that all life is growth and all growth is movement of some sort. A thing which does not grow you say no longer lives; it is dead. You know that to live a thing must grow—and all species of growth are merely forms of movement. So the tree differs from the piece of iron, the slab of marble or lump of coal, in that it responds to its environment. When the warmth and moisture of spring follow the wintry snows, the tree puts forth its leaves, covers itself with the bloom of flowers, yields us fruit, and so on. The pond-lily, the "four o'clock," or *M. Jalapa*, will open and shut at regular hours of the day. The "sensitive plant" will curl and withdraw its leaves at the slightest touch.

It is, however, admitted by all that many of the lowest forms of life cannot be assigned to either the vegetable or animal kingdoms with any degree of assurance. Take, for instance, the *Volvox Globator;* the botanist regards it as a plant, while the zoölogist assigns it to the animal kingdom. Somewhat similar are the *Gregarini*, which are found in the intestinal tracts of animals. But there is no difficulty in finding a line of demarkation between the higher animals and other forms of existence. If, in hurrying through the crowded and busy streets of a great city, a man jostles against a barber pole, or lamp post, or collides with a tree or the wooden Indian sign in front of a cigar store, we find that none of these objects are in the least disturbed by the occurrence. They stand as firmly, securely and stolidly as ever. There is no response of any sort on their part. On the other hand, the man responds with a sudden start, and, unlike the wooden Indian sign, his face completely changes its expression, while his devotions, which are accompanied by various exclamatory outbursts, are feelingly directed toward the contused parts of his body. He feels. The barber pole, lamp post, tree and Indian sign do not feel. Or, to express the same thing in equivalent terms—the man has a nervous system; the other things have no nervous system.

You already realize the fact that the body and mind are closely connected, and that Psychology must always take this connection into account. This and many other facts make at least a general knowledge of the nervous system absolutely essential to the student of Psychology. The nerve elements are capable of being divided into two classes—(1) *nerve fibers* and (2) *nerve cells.* In addition to these two a third might be mentioned—an intermediate basis tissue called the *neuroglia*, which exists more abundantly in the larger nerve centers, such as the brain and spinal cord. It has been quite generally regarded as mere connective tissue, and some authors give to it the name "nerve cement." It is highly probable that in all animals the new nerve fibers and new nerve cells are evolved from this intermediate substance. What is generally called a "nerve" (as when the dentist speaks of "treating a nerve") appears to the naked eye as a cord of a whitish color. If we closely examine this nerve we soon discover that it is a bundle made up of many smaller strands. Each of these strands is called a nerve fiber, which is in turn composed of elementary fibrils. The nerve fibers vary in thickness from $\frac{1}{1200}$ to $\frac{1}{100000}$ of an inch. The smaller ones are found at the termination of the nerves in muscles, glands and membranes, as well as near the endings in the skin on the outer surface of the body. Here they are extremely fine and interlace with one another, forming an intricate net work. Sometimes the fibrils fuse more or less completely, so that the fiber appears either structureless or merely shows signs of fibrillation. The fibers are of two classes, the medullated and non-medullated. The medullated are so named because they consist of a central nerve axis surrounded and enwrapped by a sheath of very thin membrane and a semi-liquid granular substance, called the "medullary sheath." The medullated nerve fibers are found only in vertebrate animals, and are especially abundant in the brain and spinal cord. The central portion of the medullated nerve fiber—the portion enveloped by the medullary sheath—is its most important constituent; it is almost translucent, and is called the "axis cylinder." The chief characteristic of the non-medullated fibers is that in them there is no sheath or outer membrane present. In nearly all the visual nerves, as well as the fibers of the olfactory and some others, the sheath is absent. As stated above, both the medullated and the non-medullated nerve fibers tend to group themselves into cords or fascicles of different sizes, the individual fibers of which run parallel to one another and are invested by a sheath. These again, in their course toward the center, collect into larger and larger fascicles, the different constituents of which are all bound together into one white nerve. These nerves frequently contain within the same fascicles both ingoing and outgoing fibers, and are then denominated "mixed" nerves. Others contain only those fibers which carry the currents in and are called sensory or afferent nerves. And a third class is that group of nerves which contains fibers whose function is to convey impulses toward the periphery. They are called the motor or efferent nerves.

The nerve cells are very different from each other both in size and shape, as well as in their special functions.

In size they range from $\frac{1}{5000}$ to $\frac{1}{250}$ of an inch in diameter, and in shape they are as varied as the feathery snowflakes of a winter's storm. Thus the brain abounds in cells which are pyramidal in shape, while the multipolar ganglion cells are characteristic of the anterior or motor region of the spinal cord. Nerve cells are more or less granulated bodies, each of which contains a large nucleus, and within this is usually a distinct "nucleolus."

The substance of the nerve cells gives off two or more processes which are either much branched (called ramifying processes) or simple. It is by means of these processes of various sorts that the nerve cells are united to the central extremities of the nerve and to each other. Very frequently, under the microscope, fibrillations can be seen passing from one nerve process in a curved line through the body of the cell and into another process; while in others the same process can be traced through the cell in various directions. Thus it is arranged so that many nerve currents can pass through one of these compound nerve fibers just as, by use of the Edison key, one telegraphic message can be received and another can be sent over the same wire and at the same time.

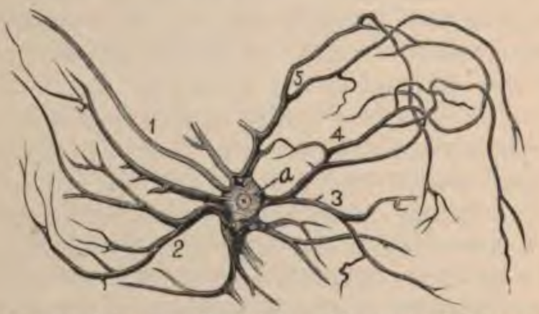


FIGURE 1.—A multipolar nerve-cell, with branching (1, 2, 3, 4, 5) nerve processes. *a*, nucleus, containing nucleolus.

The exact manner in which nerve fibers and nerve cells are connected is not known as yet. The views of Retzius on that point are certainly the best.* At any rate it is very evident that cells and fibers have no functional existence apart from each other. Whenever and wherever we have nerve fibers we have nerve cells, and *vice versa*. Viewed in their entirety with reference to their functions and interdependence, indirect as it may seem to be, it is evident that nerve fibers and nerve cells together constitute a system — the nervous system. The nervous system of man and the higher animals consists, then, of the following necessary parts: (1) Conducting Nerves, comprising (a) afferent sensory nerves carrying the currents in, (b) efferent motor nerves carrying the currents out, (c) mixed nerves; (2) Central organs, such as the spinal cord and brain; (3) the end organs (a) of sense, as the skin, the eye, the ear and taste bulbs, (b) of motion, such as the attachments which connect the nerves and muscles.

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*Zur Kentniss d. Nerven systems d. Crustaceen, Gustav Retzius, Leipzig, 1890.

The spinal cord and brain are the great centers of the cerebro-spinal system. These great masses of nervous matter are situated in the bony cavity of the skull and spinal column. Both the brain and spinal cord are invested with three coverings or membranes. The outer one is called the *dura mater*, and is tough, white and fibrous. It adheres very closely to the bones, especially in the skull. The second is called the *arachnoid* membrane, and is smooth, firm, and is kept very moist by means of an alkaline fluid. The inner membrane is vascular, and is called the *pia*. Its network of fine arteries and veins are thus in contact with the nervous tissue itself. The function of these three membranes is to protect, hold together and nourish with blood the spinal cord and the brain.

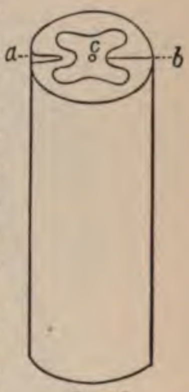


FIG. 2

Showing section of the spinal cord.

a. Anterior fissure.
b. Posterior fissure.
c. Central canal.

The spinal cord is a long tube of nervous matter, and extends throughout the entire length of the spinal canal. It is, therefore, from fifteen to eighteen inches long in the adult person. It is nearly cylindrical in shape, its front and back surfaces being somewhat flattened. The spinal cord is almost completely divided throughout its entire length into right-and-left halves, by two median fissures. The one in front (anterior) is the broader, the one behind (posterior) is narrower but deeper. The two halves of the cord are held together by two bands called commissures, which are situated at the base of each fissure; the one in front is the "white commissure," the posterior one is the "gray commissure." The fibers of this posterior gray commissure inclose a minute canal which extends the entire length of the cord (central canal).

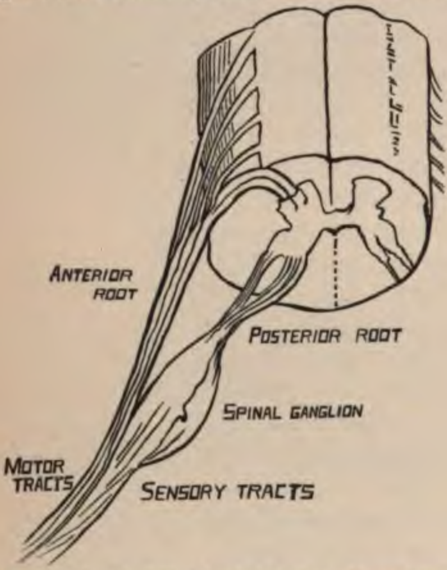


FIGURE 3.—Section of spinal cord, showing anterior (motor) and posterior (sensory) roots (after Edinger).

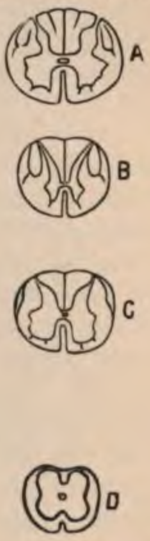


FIGURE 4.—Transverse sections (schematic) of the spinal cord at different elevations.

Each half of the spinal cord is subdivided by its nerve roots into three columns. These are (1) the anterior column which lies between the antero-median fissure and anterior roots; (2) the posterior column, which is between the posterior nerve roots and the postero-median fissure; (3) the lateral column lying between the anterior and posterior nerve roots. This subdivision of each half of the cord into three columns, as well as the general arrangement, is plainly shown in transverse sections at almost any elevation. The cord comprises both white and gray matter, the white being on the outside. The relative amount of white and gray matter varies at different localities of the cord. The gray matter, which is surrounded by the white, takes in each half of the cord, the shape of a crescent. The horns of this crescent terminate at the nerve roots just where the fibers emerge from the cord. The anterior horn is rounded; the posterior is long and narrow. When looked at in a transverse section it is seen that the gray columns and their commissures form a figure something like the letter H. This can be plainly seen with the naked eye.

The cord contains both nerve fibers and nerve cells. The external, or white part of the cord, consists chiefly of fibers, together with connective tissue and blood vessels derived from the pia. The gray portion of the cord contains, besides fibers, connective tissue and blood vessels, an infinite number of nerve cells. Almost all the nerve cells are multipolar, and they abound chiefly in the anterior and posterior horns of each crescent. The cells of the anterior horn are large, very distinct and stellate, forming a very well-defined group; those of the posterior horn are smaller in size.

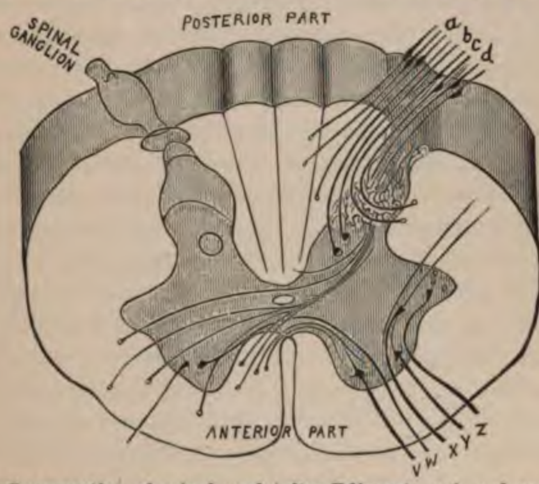


FIGURE 5.—Cross-section of spinal cord (after Edinger). a, b, c, d, sensory fibers entering the posterior horns; v, w, x, y, z, motor nerves passing out from the anterior horns. The globular (sensory) cells and pyramidal (motor) cells are also shown.

The number of nerve elements in the spinal cord has been carefully counted in the case of some of the lower animals. For example, Birge counted the fibers in the cord of a large number of frogs and found that in the anterior roots they varied from 6,000 to 12,000, according to the size and age of the animal. Of the longitudinal fibers it can be said that some ascend from below upward, conducting sensory impressions to the brain, while others descend from the brain and higher regions of the cord to the lower, and conduct motor impulse to the muscles. There are also countless horizontal and oblique fibers. Thus the nervous elements of the spinal cord are arranged so as to be both a conductor and a center of nervous impressions and impulses. It not only conducts the impressions—for example, a touch sensation from the finger upwards to the brain and the motor impulses from the brain downward to the muscles—but it is also a great nerve center. It can do a large amount of work by itself, as well as obey the commands of the brain. Many human activities are controlled by the spinal cord alone, without the least assistance from the brain. The decapitated frog is capable of making a considerable series of intelligent movements. The *Praying Mantis* will continue to fight its antagonist a long time after its head is severed. Though the human spinal cord is divided into columns and ramified by so many tracts running in every conceivable direction, it must always be remembered that the cord is anatomically as well as functionally continuous.

You see, then, that the spinal cord is a wonderfully ingenious mechanism, made up of nervous elements so combined as to serve two great purposes. Not only do we find it a pathway to and from the brain for those impressions originating at various points on the periphery as well as the impulses which take their rise in the brain, but it is itself a well-organized nervous center—yes, more; it is a well-organized group of numberless nervous centers, each one of which may be capable of, and especially fitted for, performing a certain piece of work. All these centers in the cord are by means of the various nerve fibers bound together up and down, crosswise and obliquely, making them capable of united action either in originating new impulses and processes, or in obeying the behests of the brain.

LESSON VI.

THE BRAIN AND ITS FUNCTIONS.

We now come to a brief description of the brain which includes all that mass of nervous matter which is contained within the bony cavity of the skull. It comprises four general divisions which are so apparent as to be readily distinguishable, even by the casual observer. These parts are named (1) *medulla oblongata*, (2) *pons*, (3) *cerebellum* or *little brain*, and (4) *cerebrum*.

The medulla is directly above the spinal cord and continuous with it. It is somewhat pyramidal in shape and is about one and one-fourth inches long. Like the cord, it consists of both white and gray matter. The cerebellum lies above and immediately behind the medulla. The pons, or bridge, lies above and in front of the medulla, with which it is also continuous.

With reference to the medulla it is also important to add that it is a bilateral organ with its two halves joined together by tough commissural fibers which cross from one side to the other in an oblique direction. The fibers of the spinal cord undergo an important rearrangement in their passage upward into the medulla. Thus you see that each half of the brain is connected with the sensory organs at the periphery of the opposite half of the body, and also with its muscles. The former relation is brought about by the sensory channels decussating at the base of the brain and along the spinal cord; and the latter is due to the fact that the outgoing nerve channels or motor stimuli pass from each half of the brain to the opposite side of the body, decussating with one another in the medulla. This rearrangement consists in the fibers passing through the left half of the cord and coming from the left side of the body, crossing and passing upward to the right side of the brain, and *vice versa*. Thus it is

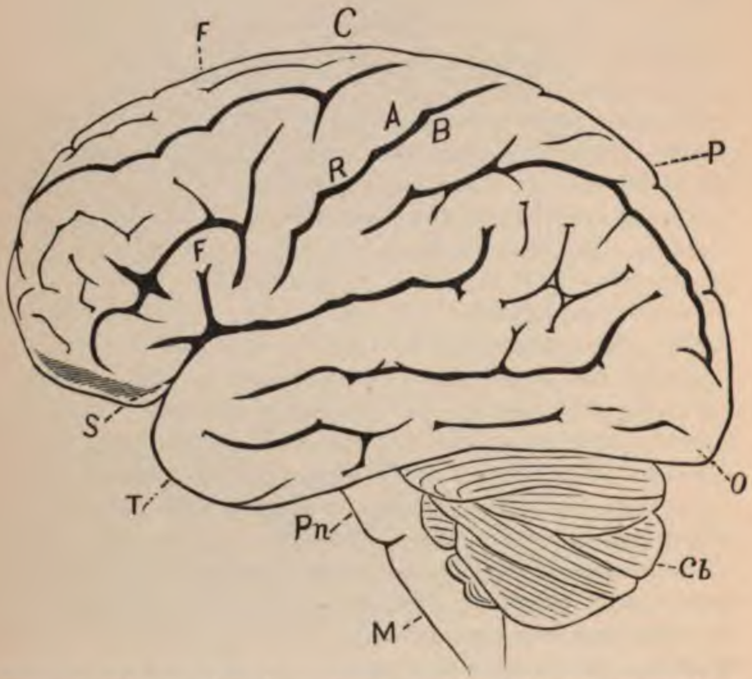


FIGURE 6.—Side view of the human brain. (Ecker.)—F, frontal; P, parietal; O, occipital, and T, temoporo-sphenoidal lobes; S, fissure of Sylvius; A, anterior, and B, posterior, central convolutions; R, fissure of Rolando; M, medulla; Cb, cerebellum; C, cerebrum; Pn, pons.

that all persons who are right-handed are "left-brained"—*i. e.*, the larger amount of brain work is done by the left hemisphere in right-handed individuals. The same relation holds true with reference to the left-handed base-ball pitcher, whether his curved balls be "in-shoots," "high-ins," or "out-drops," they are controlled by the right cerebral hemisphere. You can then readily see what a serious thing it is to correct left-handedness in a child. The left-handed child is not only left-handed but is right-brained as well. He is also left-eyed. I mean by this that his left rather than his right eye controls the movement of his hand, and after a child has been accustomed to use his left hand for the first three years of his childhood, it is by no means a small matter to induce him to give preference to his right when the change involves almost a complete transformation within the brain itself. Certain it is that the mental growth is, for the time being, in a measure retarded, and it is a question whether mental development should ever be sacrificed to convenience. It might be added that nearly all blind people read with the left hand, and with many other individuals it is used when fine discriminations are to be made, bearing out the idea of Shakespeare, when he says:

> The daintier hand hath the finer sense.

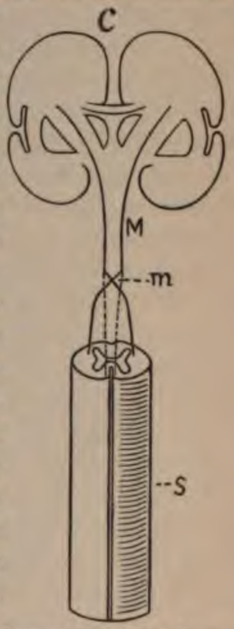
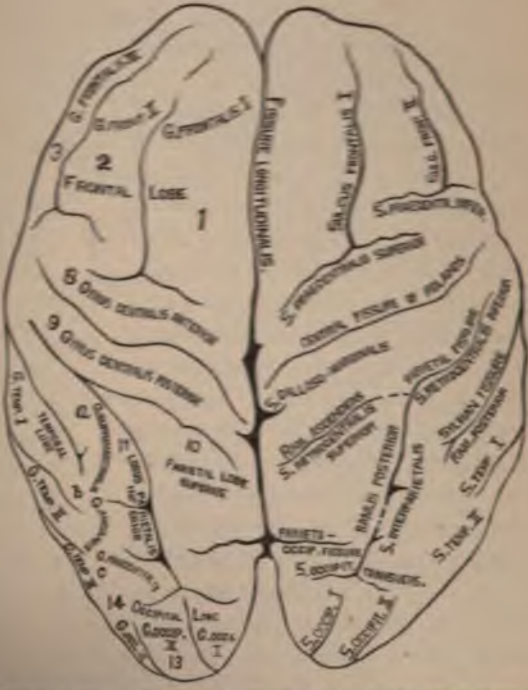


FIGURE 7.—C, cerebrum; M, medulla; m, crossing of fibers; s, spinal cord.

In the cerebellum we find that the general arrangement of the white and gray nervous matter is just the opposite of what is found in the medulla; for the white is the interior portion, while the gray is on the outside. Looked at even superficially, it is found that the cerebellum consists of two hemispheres united by a median lobe called the vermiform process. The two hemispheres are joined to each other by means of countless transverse fibers, and the entire cerebellum is connected with the medulla. The surface of the cerebellum presents a peculiar arrangement due to subdivision of its gray substance into a multitude of thin plates or lamellæ, by numerous fissures. These thin plates are penetrated more or less by fine lines of white matter. When a



8—(Convolutions—Fissures). View of the human brain from above, show- the two hemispheres as well as principal fissures and convolutions.

section is made through the organ it is found that the gations of white matter branching off into the interior of y lamellæ give to the section an arborescent ap- by the fanciful name of *arbor-vitæ*. The fibers isverse direction go from one hemisphere of the opposite side, thus constituting the connecting arrangement by means of which the two hemispheres of the cerebellum become anatomically and functionally one.

The pons is commonly called the "bridge of the brain." It is cuboidal in form, and consists of both white and gray matter. The white nerve fibers pass through the substance of the pons, either transversely or longitudinally. The gray matter of the pons is scattered irregularly through its substance, appearing also on the posterior but not on the anterior surface. The nerve cells of the pons are, as a rule, multipolar and stellate.

The cerebrum, or great brain, forms much the largest division of the nervous mass inclosed within the bony cavity of the skull. (See Fig. 6). It is an ovoid in shape, and is divided into two great halves, or hemispheres, by means of a great median longitudinal fissure. At the bottom of this fissure, when the hemispheres are spread apart, can be seen a broad white band of nervous matter (called the *corpus callosum*), by means of which the two halves of the cerebrum are held firmly together. The surface of the two hemispheres is traversed by many fissures of varying depth. It might be said that the external surface of the cerebral hemispheres appear like a tract of land traversed by many crooked brooks and rivers producing numberless furrows, which are named *sulci* or fissures, and the ridges between them are called convolutions. Between these various fissures are the folds of tissue known as convolutions, or *gyri*. No two brains are alike in the number and depth of the fissures, or in the number and prominence of the convolutions; indeed, the two halves of the same brain are not exactly alike in this respect.

By means of the various principal fissures it is an easy matter to map out the two hemispheres of the cerebrum into five lobes. These are called the Frontal, Parietal, Temporal, Occipital, and Island of Reil. All but the Island of Reil are shown in Fig. 6 and Fig. 8. It is concealed beneath the frontal, parietal, and temporal lobes.

In all parts of the cerebral cortex, the gray matter is found on the outside, while the white matter is within. The thickness of the gray matter on the brain surface undergoes a gradual increase among vertebrate animals. This gray layer is so thin in fishes that the surface of the cerebrum appears almost white to the naked eye.

But the form and distribution of the nerve cells is not the same at different layers of the cortex even in the same locality. The thickness of this gray cortex varies from one-thirteenth to more than one-eighth of an inch, and in it five layers of cells are usually distinguishable. There are about eighteen million of nerve cells to every cubic inch of gray brain matter. A large number of these cells are pyramidal in shape, so as to admit of close packing together. The human brain is *relatively larger* than that of any other animal, except the smaller birds, such as the canary. It is also *absolutely larger* and heavier than the brain of any known animal save the elephant (8 1-2 to 10 lbs.), and the largest whales (6 lbs.). Exner has compiled the following table, which shows the relation that obtains between the weight of the brain and the weight of the body. This table also shows that there is

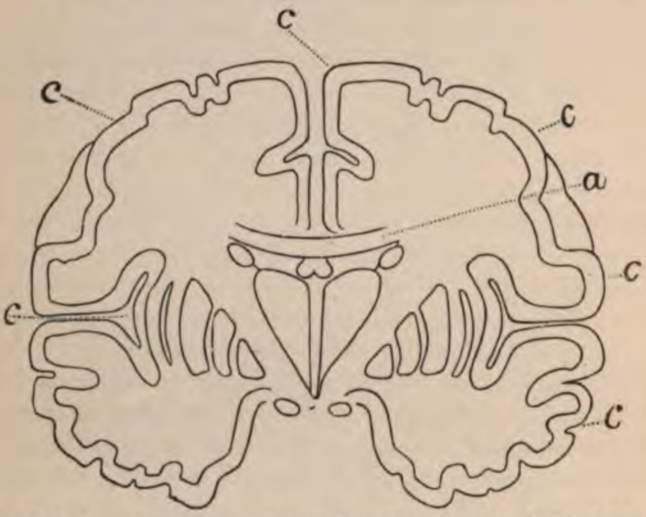


FIGURE 9.—Schematic drawing of coronal section—across both hemispheres of the brain. *cc*, outer gray layer or condex; *a*, corpus callosum.

a sort of general correspondence between the size and weight of the brain of any animal and the rank of this animal in the scale of intelligence.

Table Showing Relation of the Weight of the Brain to the Weight of the Body in Various Animals.

Tunny fish	1:37,500	Finch	1:231
Land tortoise	1:2,250	Cat	1:160
Shad	1:1,837	Eagle	1:156
Ox	1:860	Rabbit	1:140
Kangaroo	1:800	Pigeon	1:104
Tadpole	1:720	Rat	1:82
Elephant	1:500	Gibbon	1:50
Sheep	1:345	Sai ape	1:25
Dog	1:305	Canary	1:14

You can readily find some discrepancies between the rank assigned in this table and the animal's actual position in the scale of intelligence. It is obvious enough that the order indicated does not correspond with the intelligence of the respective animals. For example, none of you would regard the elephant a less intelligent animal than the sheep, notwithstanding the table to the contrary.

The fact of the matter is that brain weight has been regarded by too many as an absolute index of the relative position of an animal in the scale of intelligence. The average weight of the adult male European brain is 49 to 50 ounces, that of the adult female 44 to 45 ounces, making the brain of a man weigh, as a rule, 10 per cent. more than that of a woman. The average brain weight of the African, Malay and Mongolian is from one to four and a half ounces less than that of the Caucasian. Dr. Bernard Davis advances four interesting conclusions that have a bearing on this point: 1st, that the average brain weight is considerably higher in the civilized European than in the savage races; 2d, that the range of variation is much greater in the former than in the latter; 3d, that there is an absence, almost complete, of specimens heavier than 54 ounces belonging to the exotic races; 4th, that though the male brains are heavier than female there is not the same amount of difference in the average brain between the two sexes in the uncultivated as in the cultivated people.

At birth the brain of the infant weighs about ten ounces. It reaches the maximum size about the eighth year, but keeps on increasing in weight until the person is about 30 or 40. You remember that Byron's brain is said to have weighed 79 oz., Cromwell's 78 oz.; that of Cuvier 64 oz., that of Agassiz 53.5 oz., and that of Webster 55 oz. But in this connection it must also be remembered that high-brain weights are oftentimes found in the insane. In fact, insanity is sometimes caused by brain enlargement. In the insane asylum of West Riding, out of 375 male brains examined, thirty were found which weighed 55 ounces or upward. Thurnam reports one of an epileptic which weighed 64 1-2 ounces. When yet a boy I remember seeing a brain which weighed 62 ounces. It was the brain of an insane man who had committed suicide near our home by hanging himself. Dr. Langdon Davis examined the brain of a 22-year-old idiot, which weighed 59 1-2 ounces. The heaviest brain of which we have authentic record belonged to an insane person. The man from whom it was taken was a brick layer 38 years old, who died from pyæmia in the University College Hospital in 1849. According to Obersteiner 963 grams is the smallest recorded weight of a male brain compatible with intelligence; likewise 788 is the smallest weight of the female brain that has been found to be compatible with intelligence.

It should also be remarked in this connection that no uniform method of removing the brain from the skull has been adopted by the various investigators. Some will, in addition to the brain proper, remove a small portion of the cord, which, of course, adds to the total weight. Many brains cannot be conveniently weighed until considerable blood or moisture is lost. Thus you see the methods of comparing brains with reference to their weights leave room for improvement so far as accuracy is concerned. Brain weight can never be set down as a criterion of intelligence. A much better basis for such a judgment is found in the *amount of brain surface*. Wealth of brain surface means,

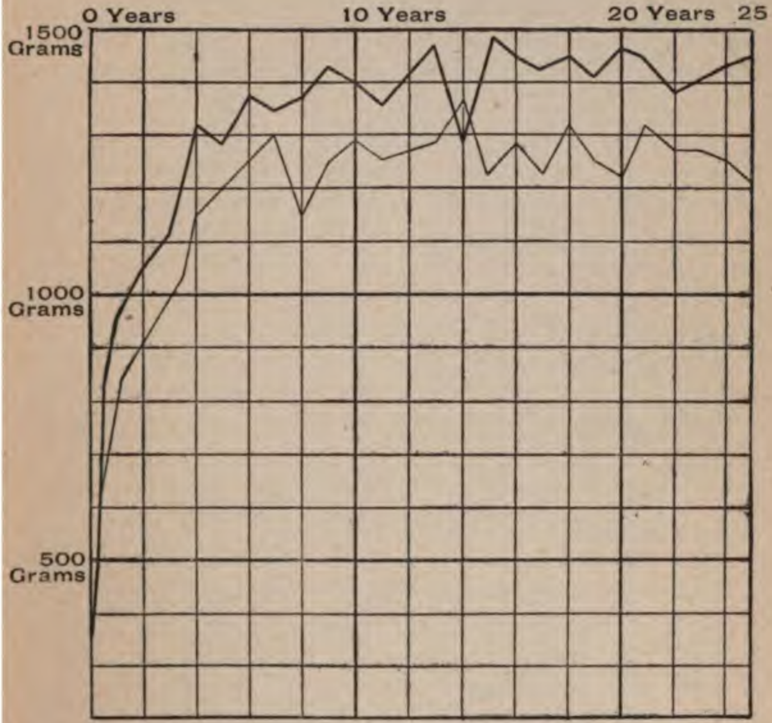
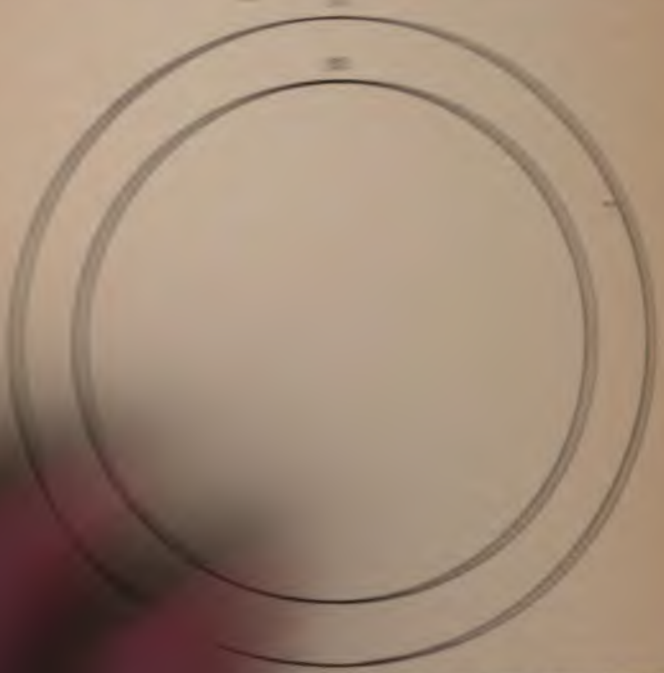


FIGURE 10.—The above curve indicates the growth of the brain with reference to its absolute weight in both males and females for the first twenty-five years. The curve is based upon the published tables of Vierordt in the *Archiv für Anatomie und Physiologie*, Band, 1890. The heavy (upper) line indicates the increase in weight of the male brain from year to year, and the light (lower) lines shows the same with reference to the brain of females. The weights are expressed in grams.

of course, a much-wrinkled, many-fissured and very convoluted brain. Of two brains equal in size and weight, the one having the more fissures and deeper convolutions is the more "intelligent" brain. Thus the brain of the Hottentot "Venus," when examined by Gratiolet, exhibited very few convolutions, and these were not at all complicated. Compare with this the brain



[illegible] the relative amount of brain surface exposed in [illegible] weight. The larger circle AA represents the entire [illegible] circle BB represents the portion [illegible] between the [illegible] the narrow area between the two circum[illegible] portion exposed in [illegible]

[illegible] examined by Bastian, and you will find that [illegible] many more convolutions which are very [illegible]. But when the latter is in turn com[illegible] of Gauss, the celebrated mathematician, you find that the latter brain has not only as many convolutions, but they are very much deeper and much more tortuous, consequently involving more brain surface—hence a brain indicative of greater intelligence. In the average brain much of the surface is sunken between the convolutions or gyri. In fact, but little over one-third of the actual surface of the cortex is exposed to view. The average extent of the entire surface of the cerebral hemispheres, including that which is sunken between the gyri, as well as that exposed to view, has been found to be 2,500 square centimeters, or about 388 square inches. The area of the sunken portion is almost exactly twice that of the portion exposed to view. It is therefore 677 square centimeters, or 258 square inches. (See Fig. 11.)

One of the most notable peculiarities of the human cerebrum is that its two hemispheres are not equally or symmetrically developed. It is not infrequently the fact in the case of right-handed persons (therefore "left-brained"), that the left hemisphere is not only more highly convoluted than the right, but it is frequently slightly longer than its fellow, causing the tip of the left occipital lobe to project distinctly behind that of the right side. In such a case the right hemisphere is rather flattened at the tip of the occipital lobe, while the left is sharply conical in its termination. In a large number of brains this is plainly observable, especially in the brains of women. I have a brain lying on my study table now (the brain of a woman) in which the left hemisphere extends more than an inch further back than does the right. Doctor Boyd, a prominent English anatomist, has also made the claim that the brain in the left hemisphere is heavier than the right by about half an ounce. This is denied by some, and would prove nothing if it were so.

When, however, you compare the brains of various animals you are soon convinced that the development and expansion (and therefore convolution) of the cerebral hemispheres form a good criterion of the animal's mental life and intelligence. If we look at the matter from a broad and general point of view, we find that the greatest importance must be attached to the great convolutional complexity in the brain of man. With respect to convolutional development man stands at the head of the quadrumanous type of animals, just as elephants stand at the head of the herbivorous type, and just as the great whale holds a similar position with respect to the carnivorous type. Though the bony cavity of the human skull, or brain chamber, is so shaped that the largest possible area is obtained for the superficial gray matter of the brain, yet the increased area thus gained does not prove at all sufficient for the needs of man's intellectual and moral life; it has still to be increased by the occurrence of further secondary foldings in the cerebral convolutions. Furthermore, there is always increased convolutional complexity in the cerebral hemispheres in the higher as compared with the lower races of man. The high degree of convolutional development attained in the brain of man is a matter of the greatest significance.

The fissures are then seemingly for the purpose of economizing space because by means of their presence there can be a considerable increase in the amount of brain surface without increasing the size of the head itself. It may be interesting to know that the brain fissures or "channels" are actually produced by the arteries. The more work the animal has to do with his brain the more blood does his brain require. The network of arteries covering the cortex become stronger and sink deeper producing more and deeper fissures, extending, as it were, the brain system of irrigation. So you see then the fact that "the higher the order of any animal's intelligence, the richer is its brain in the number of convolutions" is intimately and directly related to the other fact that the higher the animal's position in the scale of intelligence the greater is the amount of arterial blood needed and used by the brain.

The forms of brain found in the adult individuals of the lower animal species, *e. g.*, marmoset (Fig. 12,) are very similar indeed to the form found in the human embryo in certain early stages of its development. To sum up the whole matter in the form of a general conclusion, we are led to say that *wealth of brain surface, as made possible by the development in size, num-*

ber and depth of the cerebral convolutions, is the most characteristic feature of the human brain.

But far more important than the matter of brain weights, and even more significant than the amount of brain surface, is the question concerning the quantity and quality of the blood supply already mentioned in another chapter of this book. *The weight of the entire brain is ordinarily about one-fortyfifth of the body, but the quantity of blood used up in the brain is about one-eighth of that required by the whole body.* You can readily see, then, the importance of pure blood and plenty of it. This leads me to again allude to the main points that came up in a discussion of the influence of the mental states upon bodily condition, especially upon the quantity and quality of the blood supply. First, anger and other exciting passions increase the force of the heart's action, sometimes to an alarming extent. There have been instances of the bursting of a blood vessel from a fit of passion, *e. g.*, the recent death of a well-known millionaire. Second, sorrow and grief cause the blood to move too slowly, making the power to resist disease very much less than what it should be; third, good nature and cheerfulness keep the circulation regular, and in this way assist in securing good health to

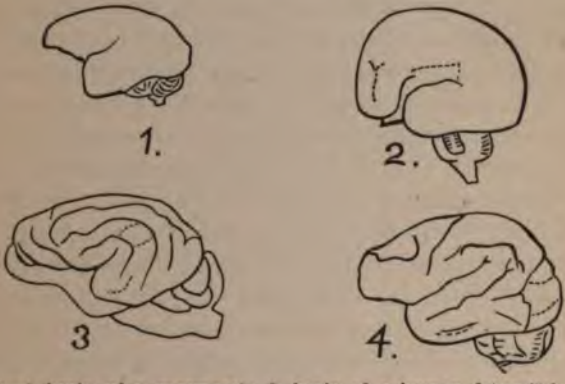


FIGURE 12.—1, brain of a marmoset; 2, brain of a human fetus (5th month); 3, brain of a fox; 4, brain of a gibbon.

the individual. You can also see why it is important that due heed be given to the effects of alcohol, drugs and tobacco upon the blood, since the brain uses such a large per cent. of the entire blood supply. One effect of alcohol is to make the blood too thin, unfitting it for nourishing the body and especially the brain. Another is to shrink the little blood corpuscles so that they cannot carry the oxygen necessary to purify the blood and keep the body properly warm. It makes the blood impure, inducing fever and inflammation. It is a well-known fact that yellow fever and some other febrile diseases are nearly always fatal to those who drink much liquor. Kraft-Ebbing, the renowned pathological specialist, asserts that a most intimate relation obtains between alcoholism and insanity—that all forms of insanity from melancholia to imbecility are found in alcoholism. Impure blood is the best of soil for the seeds of disease. With reference to tobacco, a very eminent physician says: "Youths are far more affected by the use of tobacco than men are. They accustom themselves to it more slowly, and for a long period it lessens their appetite. Boys who smoke weaken their muscles, are much less disposed to bodily activity, and are seldom inclined to exercise. Smoking, then, interferes with appetite, impairs bodily activity, and in some way damages the circulation and the composition of the blood, which must, of course, affect the brain." All these facts pertaining to the weight of the brain mass, the extent of the cerebral surface, and the influence of the quantity and quality of the blood supply, manifest in a general way the real significance of the brain for the intellectual activities. The deeply convoluted and wrinkled rind of gray matter, which is the covering of the brain, has been shown to be the physical basis of man's highest and profoundest mental life.

When we turn to experimental physiology for its deliverances we find that it points in no mistaken lines to the real importance of the different portions of the encephalic mass. If in a frog we sever the spinal cord from the brain by making a section below the medulla, we find that if the flank of the frog be touched a slight twitching of the muscles will result. If one of the hind legs be stretched out and severely pinched it will respond by withdrawing itself from the irritating cause. When the irritation is increased the foreleg will also be employed to secure relief, and sometimes the legs on the opposite side of the body, thus showing it to be a purposeful action. If you irritate this "brainless" frog at different portions of the skin with acid, you find it will perform certain remarkable defensive movements in its endeavors to wipe away the irritant. Touch the knee with the acid, it will be rubbed with the back of the foot; cut away this foot, the stump will be used ineffectually until after a pause, when the unmutilated foot will be applied to the irritated spot. When the skin over the breast is made the subject of irritation it is vigorously rubbed with both of the forepaws. This series of precise movements, manifesting purpose and design, are carried on by the spinal cord of itself. These phenomena are not peculiar to the frog alone. Other brainless animals manifest similar movements. Decapitate a salamander and pinch one of its sides; it will bend that side into a concave shape. It is said that Robin, on tickling the breast of a criminal an hour after decapitation, saw the arm and hand move directly toward the irritated spot.

On passing upward to the medulla, we find that it is given over to certain special functions, particularly those which have to do with the activities of the lowest animal life. These are much more complex and of a higher order than those, as we found above, belonging to the spinal cord. The medulla is directly related in some way to the action of the heart and to the blood vessels. It is the "central organ" for breathing, coughing and sneezing; for swallowing, hiccoughing and vomiting, as well as laughing, sighing, crying, sobbing and weeping. The breathing center in the medulla was first located by Flourens. It has since been called the "vital knot," because the least injury to it will prove fatal in that it causes cessation of breathing. That these various movements and activities are bound up in one another in their relation to the medulla is shown in ordinary strangulation, however slight. Thus, when a dry cracker crumb lodges in one's "Sunday throat," swallowing, coughing, shedding tears, and changes in the breathing and circulation inevitably result. It is quite common to hear one say, "I laughed till I cried." It can, therefore, be said that when we have an animal in which the spinal cord and medulla are united and remain intact, though severed from the superior organs, we have a mechanism that will execute movements of which the spinal cord alone is incapable. A frog, with its spinal cord and medulla will endeavor to turn over when laid on its back and when placed in the water it will swim. A young rat, in which the medulla and spinal cord are intact, but severed from the organs lying above, will squeal if its legs are pinched, and it is able to swallow; it will also kick in its endeavor to free itself.

We now pass to another question of exceedingly great interest, but one very difficult to answer, and one which is by no means settled, though master minds have struggled with the matter for over two centuries. The question is: What are the functions of the cerebellum? There is a uniform agreement supporting the conclusion that the cerebellum is the center that is most intimately associated with the balancing of the body. Thus the staggering of the man who has imbibed too freely of "Tanglefoot" whisky is due to temporary inflammation produced by congestion of the blood on the surface of the cerebellum. In the disease known as phrenitis, in common vertigo, or "blind staggers," which frequently attacks the horse, veterinarians always open the skull at a point directly over the cerebellum until several quarts of blood are set free. We find, too, in the frog having the cerebellum in addition to the spinal cord and medulla, that its locomotion is nearly normal on a level, but it cannot climb up an inclined surface; it will also croak when pinched on the side under the arms. In a recent article* I published the results of an extended series of observations made upon the brain of a cat whose cerebellum was diseased.

This cat had suddenly become paralyzed when three months old. For several days he was disinclined to eat, and all attempts at locomotion were accompanied by spasmodic jerkings. In the act of walking, the hinder parts seemed to get along considerably faster than the fore limbs, and faster than he desired, giving a ludicrous effect. After a time he recovered his appetite and again became cheerful and lively as usual. He continued to improve; and with the exception of the permanent disability to the limbs, he seemed to be as well as ever, for his development was not retarded, since he grew to normal size.

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* *Atrophy of the Cerebellum in a Cat.*—Journal of Nervous and Mental Diseases, October, 1892.

When brought to the laboratory the cat was eleven months old. While he could walk and trot his gait was zigzag and staggering, since his hind legs spread somewhat laterally in locomotion. Incoördinance of the limbs was quite marked; the hind-legs were raised very high and placed so far forward as to overstep the forelegs in walking; the movements of the head and neck were spasmodic and jerky. An autopsy revealed the fact that all portions of the brain and spinal cord were in normal condition *except the cerebellum*. With the aid of a micrometer eye-piece accurate measurements were made of the outer gray cortical layer. Over one thousand of these measurements were made. It was found that the thickness of this outer gray layer was only about half that which was found in the cerebellum of the normal cat. Since no other part of the nervous system except the cerebellum was found to be at all affected by disease, and since the cat manifested marked disturbances in locomotion, it is very evident, at least with reference to this particular case, that the cerebellum contains within its cortex the centers that are most immediately concerned with coördination of the limbs, balancing of the body, and locomotion itself.

All then that is really known about the functions of the cerebellum might be summed up in a general way in the words of Bastian, who regards it as "a supreme motor center for reinforcing and regulating the quantitative and qualitative distribution of outgoing currents in voluntary and automatic movements, respectively."

LESSON VII.

THE BRAIN AND ITS FUNCTIONS (CONTINUED).

We now come to speak more particularly of the cerebral hemispheres in their relation to man's conscious psychical life. The importance of the cerebrum as the physical basis of mental activity can scarcely be overrated. In fact, we must have some activity of the cerebral hemispheres in order to make each state of consciousness a possible fact. Unless stimulations that occur at the periphery of the body, are conveyed in some form to the gray rind of the cerebrum giving rise to some sort of neural process within it, no consciousness or "awareness," of the stimulation can possibly result. This same cerebral cortex must also take the initiative in all voluntary motions. It must be remembered, therefore, that *the physical basis of the conscious mental ities in man is the gray convoluted cerebral cortex.*

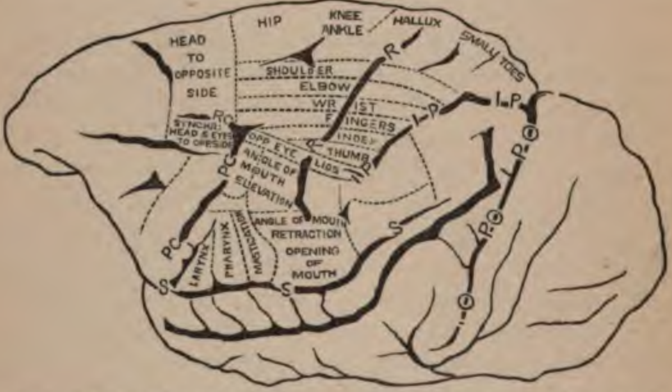

Figure 13.—Showing localization of sensory and motor functions on the lateral surface of the monkey's brain. (Left hemisphere.)

Not all parts of the cerebral cortex respond to the same sort of excitations or give birth to the same kind of sensations. Neither are all localities in the convoluted cortex concerned in motor impulses of the same group or class. The cerebral cortex is therefore a very complex organ; or, rather, it is more like a very complicated keyboard, the response coming from those parts that are in direct relation to certain specific forms of stimulation. Or, as Prof. E. Hering puts it, "The different parts of the hemispheres are like a great tool box with a countless variety of tools.

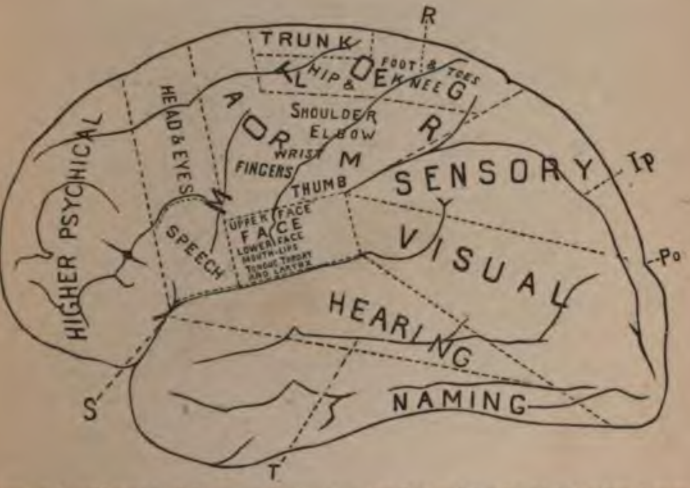

FIGURE 14.—Motor and Sensory centers on the Lateral Surface of the Cerebrum.

Each single element of the cerebrum is a particular tool. Consciousness may be likened to an artisan whose tools gradually become so numerous, so varied and so specialized that he has for every minutest detail of his work a tool which is specially adapted to perform just this precise kind of work very easily and accurately. If he loses one of his tools he still possesses a thousand other tools to do the same work, though under disadvantages both with reference to adaptability and the time involved. Should he happen to lose the use of these thousand also, he might retain hundreds with which to do the work still, but under greatly increased difficulty. He must needs have lost a very large number of his tools if certain actions become absolutely impossible."

We know, for example, that a current passing to the back part of the brain gives rise to sensations of vision. It makes but little difference whether this neural current comes through the eye or not, for you know that even a slight mechanical jar or concussion at the back of the head is sufficient to cause one to "see stars" and even comets and other luminaries. If the neural excitation occurs at some other portion of the cortical surface we have some other sensation as a result. Despite all conflicting opinions it is now a settled fact that a science of cerebral localization is possible. All of the achievements in this line of research have been made within the last twenty years, and the most noteworthy ones even more recently. The most prominent investigators in this field of research are Munk, Ferrier, Exner, Horsley, Schafer, Goltz, Fritsch and Hitzig.

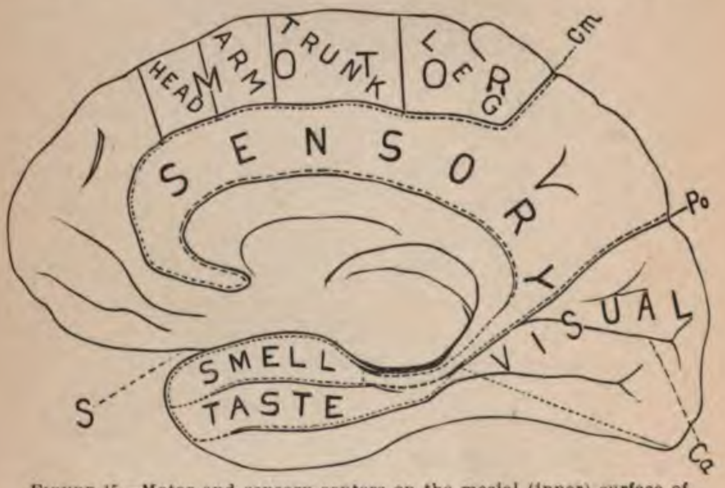

FIGURE 15.—Motor and sensory centers on the mesial (inner) surface of the cerebrum.

The first attempt in this direction was made by Gall, who founded the so-called "Science of Phrenology." He started with the presupposition that the skull, being the case containing the brain, ought show the brain formation itself. Such an assumption, while partially true, is in the main erroneous, since it overlooks the fact that the skulls of different individuals, or the same skull at different portions, vary greatly in thickness. He also lost sight of the fact that the skull bones can and do sometimes thicken both ways. A prominent "bump," like that of "Vanity," "Ambition," or "Memory for Words," may really be found on the cranium of a person entirely devoid of the qualities suggested. The errors of phrenology are now quite generally admitted, and so bald are these mistakes that in scientific circles it is entirely abandoned, because as a "system" or "science" it is fallacious in every respect. The remarks of the southern colored preacher, with reference to the "efficacy" of phrenology, is certainly to the point; if his thought is not clothed in the most elegant language, his deductions are none the less pertinent—"Brudders and sisters! Do I heah you'n's talk about phrenology? Don't you know dat you can't tell how many hams dey is in de smokehouse by feeling ob de roof?" Certain it is that, altogether defective in its psychological analysis, preëminently unsatisfactory in its localizations, unreliable in its methods, and inconclusive in its results, there is nothing in phrenology that merits the respectful attention of the real student.

It is a perfectly well-established fact that the so-called "central" convolution (situated on either side of the fissure of Rolando, see Fig. 6) forms the region from which nearly all the motor impulses pass out from the cerebral cortex. All authorities agree that the motor regions do lie around this fissure of Rolando. So certain is this that it is called the "motor zone." More plain and clear than a detailed description are the accompanying figures, which exhibit the arrangement of the specific centers, more especially those in the motor zone on the surface of the monkey's, as well as the human, cerebrum. (Figs. 13, 14 and 15.)

One of the most interesting and instructive truths bearing upon the question of localization of cerebral function is based upon evidence supplied by the disease known as *aphasia*. Aphasia is a general name given to the disease which involves a partial or complete loss of the faculty of intelligent speech. It is not caused by any structural impairment of the vocal organs, but by some lesion in the cortex. The cortical area generally affected in this pathological state is the posterior third of the third frontal (or Broca's) convolution. (See “Speech” center, Fig. 14.) Aphasia is neither the loss of the voice nor paralysis of the tongue or lips. The phenomena of this disease are exceedingly varied. In all true aphasia the connection between ideas and articulate language is interrupted within the cortical areas of the cerebrum itself. Speech processes in the cerebral cortex are both sensory and motor. By means of the sensory, language is received; by means of the motor processes, it is uttered. We have, then, both sensory and motor aphasia. In the aphasic state, though the mental condition may be more or less impaired, it is never so to such an extent as to prevent the formation of ideas. The difficulty lies in the fact that the patient cannot recollect the appropriate words or their meaning, and is thus unable to give his thoughts the proper expression. In other words, he has lost the power of coördinating and arranging the elements of a sentence in a proper manner for the purposes of spoken or written language. The patient is always cognizant of his errors in utterance. To illustrate: A case occurred recently in one of the New York City hospitals. The person afflicted was a man of more than ordinary intelligence. He desired a knife with which to eat his food. He had a clear idea of what he wanted; he wanted a knife. But, mark you, each time he attempted to say “knife” the words “bushel of wheat” would come unbidden from his lips. You see that, notwithstanding his clear idea of the object desired, he [illegible] bring about the appropriate processes of innervation [illegible] f which he might utter the proper word.

[illegible] ite similar to another case, that of a young lady of [illegible] vho suddenly became unconscious while straining to lift a heavy load. When consciousness returned she showed no signs of paralysis, but it was with difficulty that she found words with which to speak. She would confound or mutilate the commonest names—*e. g.*, she would say "butter" instead of "doctor." Not understanding a single word spoken to her, she was at first taken to be deaf, but it was soon discovered that she heard the knock at the door, the tick of the watch, or the hum of a bee as distinctly and clearly as ever before, and she could also distinguish the pitch and quality of tones.

Quite recently, while in Germany, my attention was called to a very interesting case of asphasia in one of the hospitals of Berlin. A German army officer had been thrown from his horse in one of the military maneuvers which took place in the celebration of the anniversary of the battle of Sedan. In the fall he received, his head struck the hard concrete pavement; at first he was unconscious. Soon after his return to consciousness it was discovered that he could not articulate a single word. Every attempt at utterance resulted in dismal failure. Nothing came of his painful endeavors save a series of unintelligible and incongruous sounds. After five weeks an examination of the brain itself was determined upon, for after a careful diagnosis the trouble could be assigned to no other cause than to an injury to the speech center itself. The operation of trephining took place. When a small portion of bone was removed, a little hardened clot of blood was found between the dura mater and the skull bone itself directly over the speech center, as indicated in the figure on page 75. This blood clot was carefully removed by washing with a jet of warm distilled water. Three weeks after the operation was performed, the patient had fully regained his ability to speak and write correctly.

A still more interesting case is that reported by Doctors Carson and Bremer, of St. Louis. The patient is a healthy and well-built man of about twenty-one years. Two weeks previous to the doctor's visit he went to a wedding, became intoxicated, and on his way home fell between the joists of a new building. This was his *statement subsequent* to his recovery after the operation.

He went home and was found asleep in the kitchen of his parent's house the following morning. Except what appeared to be the effects of the liquor he seemed to be in his usual health. In fact, nothing was mentioned by him with reference to his fall. Being out of work, he stayed at home and rarely left the house, complaining off and on of a dull headache on the left side of the forehead, which became more violent in the afternoon. After about one week he began to stay about his home. While walking on the street about one block from the house he suddenly became unconscious and fell. This unconsciousness did not last long, however, and he was assisted home by a person who was near at the time. Soon after, it was discovered by his family that he had some difficulty in speaking. He now for the first time intimated to his family that he met with an accident on the night of the wedding.

There was no trace of any injury to his head. He understood every word that was spoken to him, every question that was asked. Unfortunately, although not entirely illiterate, the patient was not possessed of sufficient education to render very profitable the examination with a view to discovering the particular form of aphasia. Only the most elementary questions could be asked of him, the scope of his intellect being limited. In order to test his mental caliber and ascertain the nature of the trouble in his speech a number of questions were asked. The principal ones were:

Do you know what this is (showing him a glass)?

Ans. Zer.

Q. Is it a glass?

Yes.

n a pitcher is shown him he calls it a "tipper;" a pen s "riglah;" a spittoon "sempen," a hat "sem."

o you call this (the hat) "sem?"

t?

his (showing him a match)?

In order to demonstrate that he knows what it is, he makes the movement of striking a match. A book he calls "pok," handkerchief, "sempence;" suspender also "sempence;" for pocket-knife he gives the correct name; but when shown a bunch of keys, he also says "pocket knife." After this he calls everything that is shown him "pocket;" for example, a watch and a button.

When requested to repeat a word spoken to him he is unable to do so. He understands perfectly what he reads. He is handed a newspaper with an advertisement of an entertainment in the St. Louis Exposition Building. By putting a great variety of questions, some of them misleading, one becomes aware that he is familiar with the location of the building and the purposes for which it is built. He is asked to read an advertisement of a boxing match, the name of the prize fighter is pointed out to him and the inquiry is made, What is he? Is he a preacher? This causes him to laugh. In short, there is no flaw in his perceptive and reasoning powers as far as can be ascertained by a necessarily limited conversation, and as far as short acquaintance will allow. On being told to write, he holds the pen in an awkward manner and drops it repeatedly. He never has been much of a penman, but has been able to write simple letters. It is now utterly impossible for him to express his thoughts in writing, and even the most commonplace and everyday expressions, when dictated, he fails to fix by letters.

An operation was agreed upon, a portion of the bone was trephined and when the dura mater was exposed it presented a dark cloudy appearance with all evidence of pulsation wanting. Upon raising the dura, a stream of dark, thick blood forced itself through the opening. With a dull-edged curette the greater part of the clot was removed and smaller portions subsequently taken away by means of saturation with a very fine sponge. The extent of this blood clot is outlined in the accompanying figure. (See next page.) The patient soon returned to consciousness, apparently none the worse for the operation. On the next day after the operation the patient was stupid and unable to speak, his condition being that of complete motor-phasia. On the second day after the operation, in all efforts to speak, he prefixed "shay" to words. He could, however, answer "yes" and "no" correctly, "yes" having the "sh" sound very marked. A watch was pronounced "swat," keys "shkeys," half-dollar "shalf-dollar." On the third day, in answer to questions, he said that he "felt well" and that he "liked the hospital." He could speak words without the sibilant sound. On the fourth day all words were spoken correctly, and reply made to all questions with clear answers. Three months after the operation finds the patient rd at his daily tasks in a brickyard. He is now in his usual th, with all his faculties intact and a steady worker.

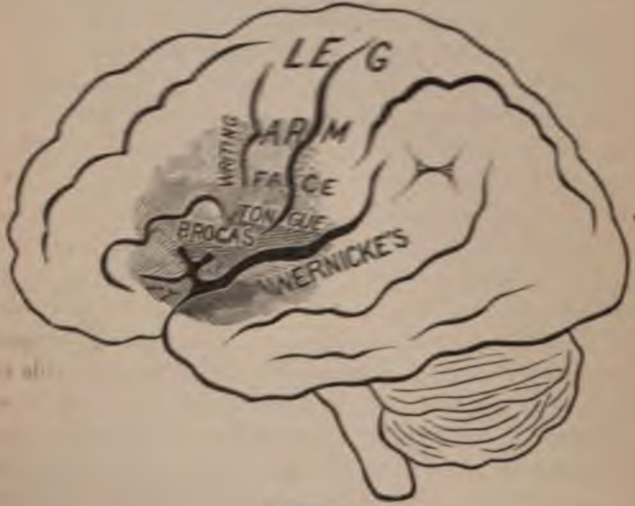

FIGURE 16.

. Laplace, of Philadelphia, reports in one of the recent jour- a singular aphasic case of surpassing interest. The person, 'nstance, suffered from a gun-shot wound in the brain, form of aphasia, in which the loss of names was the ature. The report reads something as follows:—

d Nervous and Mental Diseases, March, 1893.

August 4, 1892, Lizzie Albert, aged nineteen, received a gunshot wound in the forehead at the apex of the glabella; there was a fracture of the skull, and penetration of the bullet, according to the testimony of the physician who saw her immediately after the accident. She became unconscious and remained so during three weeks. Meanwhile several splinters of bone were removed from the seat of the penetration of the bullet. The wound gradually healed, leaving a slight depression. As she recovered consciousness, she complained of a severe pain, constant and almost unbearable, the seat of which was in the left occipital region, keeping her mind always fixed upon that point; she suffered no pain otherwise about the cranium. The patient is a strong young woman. As a result of the injury most interesting intellectual symptoms occurred, her physical condition, however, remaining entirely unimpaired. When complaining of the pain at the back of her head, she says that she "sees it;" when asked what? she answers "Yes." If asked "What hurts?" she says "It hurts." When asked if the bullet hurts, she says "Yes."

It seems that the various organs of sense refer their impression to the same centers. For instance, if asked if she hears a particular sound, such as a tuning fork, she will answer, "Yes; I *see* it." If given anything to take and asked whether she likes it, she answers, "Yes, I *see* it." Likewise if anything is given her to smell, she says she also "sees" the sensation of smell. It seems to her an impossibility to repeat a word spoken to her, though she fully understands everything. *In her conversation she uses no names of persons or things, but knows every person and recognizes everything.* For instance, if shown a hat and asked what that is, she will say, "It is yes;" but asked the name of it she will say, "I do not know." If asked, "Is this a book?" she will say, "No." "Is it a hat?" she will say "Yes." Should we write on paper the word cap, in presenting her the hat, she will say, "That is not it." If changing the word slightly we make it "coat," showing her the hat, she will say, "That is not it." If, changing the word slightly and writing the word hat, and asked whether that was it, she will say, "Yes." If asked her name, she will answer, "I do not know." If asked whether her name is Katie, she will say "No." If asked whether it is Lizzie, she will answer "Yes." Asking her to write her name, although she says she does not know her name, she will write it correctly—Lizzie Albert. If asked whether that is her name, she will say, "Yes." If asked what her name is, "I do not know," "I cannot tell you." Should I write her name, misspelling it in any manner, she will say immediately, "That is wrong." If asked, "What is wrong?" she will point out the letter in the word which makes it misspelled, and until the name is properly spelled she will insist on its being wrong.

Her judgment seems to be perfectly clear; that is, she says or does nothing which would in the least compromise the condition of her intelligence. There seems, however, to be a destruction of such fibers as lead to those portions of the frontal lobe as constitute the center of memory for names of persons and things.

Another disorder very similar to aphasia is that known as *agraphia*—the loss of the power to write. Such persons can speak correctly, can read writing and understand it clearly, but it is impossible for them to use the pen at all, or, in partial cases of agraphia, many errors are made. I happen to be acquainted with a well-educated woman living in Cleveland who is partially agraphic. With two exceptions she can make every letter with facility; indeed, she writes a very legible hand. But the two letters—k and r, which, by the way, occur in her own name, present insuperable difficulties. Try hard as she may she cannot possibly write these two letters. She knows exactly what letters she desires to make and how they ought to be made; she knows just what movement of the fingers is required in each case, but she cannot bring about the proper movements themselves. There is no paralysis of the fingers or hand, she simply finds it impossible to bring to pass those central processes of innervation that are necessary in the formation of these two letters. In writing her own name she makes instead of the k and r two characters which are more like some of the forms included in the

Chinese alphabet than they are like the letters she endeavors so hard to make.

There are some cases recorded in which highly cultivated persons are unable to make a single letter with a pen. Others will arrange the letters improperly, making a meaningless jumble, instead of words clear in their meaning. The following interesting case is recorded by Dr. Jackson:

"An elderly, healthy-looking woman suddenly became ill five weeks before admission to the hospital. She lost the entire power of speech for a week, and was also paralyzed on the right side. When examined there was no apparent hemiplegia, but she complained of weakness in the right side. She could then talk but made mistakes. For instance, when I was trying her sense of smell, which was very defective since the paralysis, she said in answer to a question, 'I can't *say* it so much,' meaning she could not smell so well. She frequently made mistakes in spelling and called her children by wrong names. This was never very evident when she came to the hospital, and might have easily been overlooked, but her friends complained much of it. She seemed very intelligent. Her power of expression by writing, however, was very bad, although her penmanship was pretty good, considering that she wrote with her weakened right hand. She wrote the following at the hospital. I first asked her to write her name. I do not like, for obvious reasons, to give her real name for comparison: it had not, however, the slightest resemblance to the following in sound or spelling:

'Sunnil Siclaa Satreni.'

When I asked her to write her address, she wrote—

'Sunese nut ts mer tinn-lain.'

Thinking she might have been nervous when she wrote at the hospital, she was asked to bring something she had written at home. She did so, but the specimen was not the least bit better than what she had previously given. It is a perfectly meaningless assemblage of letters, notable only for the frequent repetition of small groups of them in a fashion which is frequently the case in agraphic persons. The center immediately concerned in these agraphic disorders is quite definitely located, being, of course (in all right-handed persons), on the left side of the brain, and within the finger, thumb and wrist region indicated in the figure. (See Fig. 14.) In case this center when diseased does not get well the patient usually educates his right hemisphere, i. e., learns to write with his left hand."

In the same way that the understanding for spoken and written words can be lost to the patient, so can the power of understanding and comprehending figures. A case has been recorded of an accountant who was perfectly able to read the number 766 a digit at a time, but had no comprehension of the value of a group of these figures. In all cases of aphasia the patient is somewhat in the position of the intelligent animal who hears well enough the language addressed to him, but cannot make reply or fully understand its deepest meaning. Or perhaps a better analogy would be the case of the Irishman who, when looking in the window of a tea shop at an advertisement with its array of Chinese characters, being asked if he could read these arbitrary signs, replied that he could not read such "spalpeen" characters, but that he could play them on his flute.

The classical case of the patient Le Long, recorded by Broca, serves well to illustrate the condition in incomplete aphasia. "Le Long had command of only five words which he would add by way of supplement to the expressive gestures he usually employed; they were oui, non, tois (for trois), toujours, and Le Lo (for Le Long), three complete words accordingly, and two mutilated ones. With his *oui* he expressed affirmation, with *non* negation; with *tois* he expressed numerical concepts of all degrees [illegible] ble to indicate by a dextrous employment of his fin[illegible] bers he had in mind; with *Le Lo* he denoted him-[illegible] used when he was unable to express his thoughts [illegible] r words at his command. Le Long pronounced [illegible] correctly, but omitted it in *trois*, as children do that have not yet overcome the difficulty of uniting the *r* with the preceding *t's;* he had lost beyond recall this knack of articulation. The nasal sound which he correctly articulated in *non* he could not give to the last letters of his own name."

The remarkable fact that in the function of speech the left hemisphere is more directly concerned than the right, is now well established. Seguin found from a collection of two hundred and sixty reports of cases of this type, that the number of instances in which aphasia arises from lesion on the left side, stands in proportion to the number of those in which impairment occurs on the right side, as 14.3:1; with reference to which it must be remarked that—as has been shown by other calculations—no deception is here caused by the possible circumstance that in general more injuries occur on the left side than on the right. As Exner relates: "In this connection a case reported by Schwarz is of interest. In a well-developed three-year old girl, during convalescence from measles, speechlessness with partial paralysis of the right arm suddenly set in. The lesion accordingly lay in the left hemisphere. The condition of the patient improved, yet the girl had to learn to talk again from the very beginning, and in so doing acted like the normal child that is learning to speak."

The analogy is still further applicable. It appears that so-called left-handed individuals, who, as contrasted with the majority of men, have trained their right and not their left hemispheres to perform mechanical work, also employ their right hemispheres in speech. Pye Smith, Jackson, and John Ogle, Mongié, Russel, and William Ogle have observed cases that appear to substantiate this. Left-handed people had become aphasic through lesions on the right side of the brain, and a fact which proves more—in a collection which William Ogle made of one hundred cases of aphasia, there were three left-handed men, and in the case of each of these, the lesion affected the right hemisphere."

The *center of hearing* lies in the temporal lobes. We know this because artificial stimulation of these portions of the cerebral cortex causes hallucinations of hearing. The "roaring" in the ears which so frequently follows an overdose of quinine may also be instanced in this connection. In *post mortem* examinations the temporal lobes of deaf patients are generally found to be in an atrophied condition. Seppili reported a few months ago two interesting cases in this connection. The first was that of an autopsy on a deaf mute, a wound of long standing being observed in *both* temporal lobes. The second was the case of a left-handed person, whose left temporal lobe showed an old wound, no difficulty in hearing or speech having been experienced. From this and analogous cases Seppili concludes that in a left-handed person the auditive center of language is situated within the right hemisphere. His results form an interesting contribution with reference to the well-established principle that right-handed persons are left-brained (and *vice versa*), even with reference to such functions as speech and hearing, of which right and left handedness cannot be directly predicated.

The visual center in the human brain is in the occipital lobes. The most interesting pathological case in support of this view is that of the blind deaf-mute, Laura Bridgeman, the structure of whose brain has been studied with such painstaking thoroughness by Professor H. H. Donaldson.* From a paper read by Dr. Donaldson before the Congress in Experimental Psychology which met in London, August 1892, we make the following excerpt:

"Laura Bridgeman was born in 1829. She was a normal child and her development was undisturbed up to the end of her second year. At this age she suffered from an attack of scarlet fever which was very severe and from which the convalescence was tedious. It was then found that her senses of taste and smell had been much blunted, and that hearing had been entirely destroyed. Vision in the left eye had been completely lost, but was retained in the right to a very slight extent. In her eighth year this remnant of vision was also lost. It was at this time that Dr. Howe undertook to educate her through her dermal senses alone.

The remarkable results of his undertaking have now become

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ican Journal of Psychology, Vol. III, No. 3; Vol. IV, Nos. 2 and 4.

classic, not only because it required first-rate qualities in the teacher, and also it was the first time that an attempt had been successfully made to give an adequate means of expression to one thus defective. Laura died at the Perkins' Institute for the Blind at Boston in 1889, being in the sixtieth year of her age, and still mentally vigorous. Among other things the anatomical study of the brain revealed the following facts:

"The thickness of the cortex was determined by the examination of fourteen localities in each hemisphere. From these observations an average thickness for the cortex was deduced, and this was compared with an average similarly obtained from a number of normal brains. The figure of the average thickness of the cortex of the Bridgeman brain was 2.62 mm., that for the normal brains 2.91 mm. The Bridgeman brain was therefore thinner by 0.3 mm., or about 11%. In this connection it is interesting to notice that those parts of the cortex which, according to the current view, were to be associated with the defective sense organs, were also particularly thin. The cause of this thinness was found to be due, at least in part, to the small size of the nerve cells there present. Not only were the large and medium sized nerve cells smaller, but the impression made on the observer was that they were also less numerous than in the normal cortex.

"Suggestive also was the fact that the cortex in the right occipital region, associated as it must have been with the left eye (the eye in which vision was earliest abolished), was much the thinner. This observation suggested that the case might be used to determine the extent of the visual cortex in man. It was assumed that in this case the earlier loss of vision in the left eye had been the cause of the excess of thinning on the right side and that the extent of this thin area would represent that portion of the cortex directly influenced by the optic radiation."

The researches in histology show clearly that in higher animals, more particularly in man, the optic nerve contains one system of fibers which cross over to the opposite side and o system which remains uncrossed. The relation is peculiar, however, in that the fibers from the left half of each retina go to the left hemisphere, while those of the right halves of the retinas go to the right hemisphere. The retina of each eye in the case of man appears therefore to be represented on the cortical surface of both hemispheres of the brain.

With reference to a cortical *center for the sense of smell* it can be said that we have anatomical evidence of considerable value. The intimate connection of the olfactory tract with the tip of the temporal lobe certainly furnishes strong grounds for supposing a functional connection between that region and the sense of smell. The experiments of Ferrier* have the most direct bearing on this point.

So far as known, the frontal lobes do not contain either sensory or motor centers. It has been regarded by some as the seat of the higher psychical activities, such as reflection, comparison and judgment. The emotions and affections are also assigned to this region of the brain. When the frontal portion of the hemispheres is removed in animals, *e. g.*, the monkey, no irregularities in the exercise of the motor or sensory functions occur; yet in such cases the animal appears more whimsical and less affectionate than before the operation.

In connection with what has been said in this chapter with reference to the localization of the cerebral functions and of the importance of these cortical areas in the relation to the motor and sensory life of man, it seems strange that occasionally man may lose much of the cortical gray matter of his brain without exhibiting any serious impairment of his faculties. If perchance any of the motor centers on one hemisphere have experienced an injury, the result will be the impairment of the body, yet the loss of some few of the sensory centers on one hemisphere will not be perceptible so long as the corresponding centers on the other hemisphere remain sound, except in this, that the person with but half a brain in normal condition will tire more easily than the person in whom both hemispheres are completely intact.

[illegible]"unctions of the Brain," p. 185 ff.

There are some interesting though exceedingly rare cases in which man has lost a large quantity of the cortical matter without apparent disorganization of his psychic life. The following cases are instanced by Hermann in Vol. II of his *Physiologie:*

"Berenger de Corpi tells of a young man into whose brain a body four finger breadths in width and as many in length had been driven so deep that it lay concealed by the matter of the brain. When it was removed a certain amount of cerebral substance was lost, and thirteen days afterwards a second discharge occurred spontaneously. The man recovered, showed no diseased symptoms, lived for a long time afterwards, and attained high distinction in the church.

"Longet knew a general who, through a wound in the skull near the crown of his head, had suffered a considerable loss of brain substance. This defect permanently manifested itself by a depression in the part of the skull affected. The general preserved his activity of mind; his correct judgment in professional matters exhibited no traces of disease; only he was wont to tire quickly when engaged in intellectual work.

"Quesnay tells of an old servant whose right parietal bone was crushed. Every day cerebral matter oozed from the wound and was removed. On the eighteenth day the patient fell out of bed, which resulted in further considerable losses of brain-substance. On the thirty-fifth day he got drunk; a fresh emission of cerebral matter occurred which was caused by the patient's tearing away, in his intoxication, the bandages about the wound. On the day following it could be seen that the defect reached almost to the *corpus callosum.* The patient got well; his psychical functions were restored to their complete activity, but he remained paralyzed on his left side.

"During the blasting of a rock, a crowbar three feet and seven inches long, and one and a quarter inch thick struck a young man, and penetrating the head in the neighborhood of the joint of the left jaw, passed through the skull and came out on the same side in the region of the forehead, having thus run through the hemisphere of the brain. The man got well, lived twelve and a half years afterwards, and apart from the blindness caused by the injury to the eye, he showed no indications of abnormality, except certain fits of peevishness, caprice, and obstinacy. He also lost the former habit of profanity.

"A whole hemisphere may sometimes be removed, without injury to the higher psychical functions. But in such a case disturbances of the motor functions on the opposite side appear regularly to set in."

It is, however, quite a common occurrence in the case of animals to have large lesions of the cortical matter unattended by serious mental defects. While at Strassburg in 1891, I visited Goltz's laboratory. Among other interesting objects a dog was shown me which had undergone a lesion of the entire cerebrum. I was told that the operation had been performed two years previous to my visit to the laboratory. The dog was normal in most respects. He manifested much joy at being let out of his cage; masticated and swallowed meat; followed Prof. Ewald and myself from one room to the other; stood on his hind legs and danced about when meat was held above him and out of his reach. He would jump over a stick and also run and frolic. A second animal shown me in the same laboratory was an ape with a complete lesion of the entire *left* cerebral hemisphere. The remarkable feature in the case was that the ape reached for his food with the right hand instead of the left, as would naturally be expected. Still when eating he seemed to prefer to hold the food in his left hand. He retained his wonted sauciness and attempted to scratch the face of every person who approached his cage. Of course lower animals use their higher cerebral centers less than man, and it is quite natural that they should so well withstand the partial or even complete loss of the cortical area on the hemispheres.

You will remember that at the beginning of this chapter we spoke of cerebral localization as if it were an absolute fact, and such it actually is, if we confine our attention to man and monkeys only. When, however, we study cerebral localization in the vertebrate series, we find that it becomes less perfect as we pass down the animal scale. I havé already referred you to instances of animals, which, having lost some of the brain substance, still apparently retain their mental faculties. In addition to the examples already given, we have still another furnished also by Goltz. The case is that of the brain of a dog with the right hemisphere removed. The animal lived about fourteen months after the last operation. The senses of sight, hearing, smell, and taste were more or less impaired. In the brain of a second dog it was intended to remove the frontal portion of both hemispheres. However, in addition to the extended extirpation a secondary degeneration of the left occipital region took place, leaving as a result scarcely more than one-fourth of the two hemispheres intact. The dog lived two and a half months after the last operation. It did not take food voluntarily, but when food was given it all the mechanical processes of chewing and swallowing were executed. The so-called "emotional sounds"—barking, whining, growling, etc.—were evoked in their normal relations, respectively. In the case of a third dog, which had undergone a complete removal of both hemispheres, we find the animal required to be fed, but would properly masticate and swallow if the food were placed well back in its mouth. It could move spontaneously, would stand upon its hind legs, and walk in a fairly normal manner. It preserved only a remnant of vision, and as far as could be learned, had no sensations of hearing, taste, or smell. A rabbit is less disturbed by the loss of its hemispheres than the dog, a peculiar characteristic being that it retains the sense of hearing. Birds, reptiles, and frogs are each in turn still less disturbed by the removal of the cerebral hemispheres. When the hemispheres of the shark are removed the animal can no longer feed; it can see, but this is of no value to it, since it depends entirely upon its sense of smell. An observation of Steiner is in this connection exceedingly interesting. "If the cerebrum of a shark be cut out unsymmetrically, forced movements occur, the animal swims in a circle. If a shark be beheaded, its trunk swims in a straight line."

When we compare the brain in the various vertebrates, we fi
that man's brain is distinguished by a special development of

frontal lobes; in the monkey's brain, a special development of the occipital lobes is to be noticed; while that of the fox is characterized by a striking development of the parietal lobes.

There is still one other important modification in the arrangement of the different parts of the brain in the vertebrate series. This is the change from the horizontal arrangement, where (*e. g.*, sheep) the cerebellum, pons and medulla lie in one plane with the elongated cerebrum, to the erect position which brings the medulla directly underneath the hemispheres, and places the cerebellum immediately under the occipital lobes. This modification will seem the more significant when it is remembered that the elevation of the head causes an animal to rely more on its eyes and less upon its nose. "The animal of scent becomes an animal of vision. The jaws recede, and the different parts of the brain are piled upon one another so as to shape the hemispheres into a dome-like cupola."

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LESSON VIII.

SENSATION.

In a previous chapter it was stated that the nervous system falls into three main divisions, (a) the fibers which carry the currents in; (b) the central organs—especially the brain; (c) the fibers which carry the currents out. You have also seen that we have sensation, reflection (in the widest meaning of the term), and motion corresponding to these three anatomical and functional divisions. Sense-perception, as you know, is the power by which we gain knowledge of material things. Were it not for the impressions objects make upon our senses, we would never know objects. *A pure or simple sensation* is never ours to experience. Such a thing as a pure, single sensation is abstraction—a fiction. Our experiences are always made up of *groups* of sensations. One cannot see the yellowness of the orange apart from its other qualities—its roundness, smoothness, size, and weight. Every adult experience is made up of many sensations and not of single, simple, isolated sense-impressions.

A sensation can scarcely be defined since it is itself so elementary. We can, however, indicate its meaning by saying that a sensation is a simple mental state resulting from any stimulation being transmitted to the brain centers. This stimulation can occur in three different ways: First, by reason of some sort of mechanical jarring of the brain itself, as when a boy in his first attempt at skating strikes the back of his head on the ice and as a result "sees stars;" second, the brain centers are stimulated by means of changes in the quantity and quality of the blood supply—for example, the sensation of faintness when the blood rushes to the head or the "roaring in the ears" after a heavy dose of quinine; third, and by far the most common, the brain centers are aroused or stimulated by means of the nerve current produced by the excitation of an end-organ at the outer extremity of some incarrying or afferent nerve, being transmitted to the brain—for example, the sensation produced by touching a point on the skin with a hot iron, or that caused by the ringing of a bell, or the blast of a whistle.

The mechanical jars that may happen to the brain mass itself are exceedingly infrequent and like the sensations produced by the changes in the quality and quantity of the blood supply, are very transitory. The nerve currents, however, do play a most important part in our psychic life. *All our knowledge of the outside world comes to the mind via the end organs of sense, afferent nerves and brain centers.* We could never know the least iota with reference to objects about us were it not for the fact that in some way these objects do act upon our senses. The person born blind can have no idea at all of color, the one born deaf can have no idea of sound. Imagine how limited your experience would be, if you were simply both color blind and incapable of discriminating pitch and tone among the various sounds. What a cold, gray, monotonous world it would be if we had no appreciation of colors or musical tones! Yet such a limitation is as nothing when compared with absolute insensibility to light and sound. In the asylums and schools for the blind and deaf the pupils are taught as much *about* light and sound, respectively, as is the normal child in the average grammar or high school. But the best-taught blind pupil, with all his knowledge *about* the laws of reflection and refraction, the length and intensity of the "light waves" is infinitely far behind the infant that can *see*. The baby that extends its chubby hand to grasp the red ball or the sickly yellow "jumping jack" is far in advance of the best educated blind person who may be ever so well informed with reference to the Young-Helmholtzian theory of colors.

All education must begin with the education of the senses. Not any single sense, but all of them must be developed if you would have an evenly developed pupil as the result of your instruction. All experience is interpreted and all instruction given on the basis of *"sensation-knowledge."* You must appeal to something the child has already *seen*, *smelled*, *heard*, *tasted*, or *handled*, if you wish to convey to him the knowledge of any new object. To define a new color such as "His Eminence" or "Elephant's Breath," you must appeal to color sensations already experienced. In fact, the "new shades" of the fashion books are simply new names given to old-time colors. You cannot describe the zebra to a child without referring to some animal he has already seen—for example, the horse. We interpret all our experiences in light of our previous sensations. The fictitious Indian who is said to have lassoed the first locomotive he had ever seen as it steamed across the plains, and did so under the impression that it was a gigantic buffalo, evidently interpreted the present sensation by means of previously experienced sensations. The locomotive appeared more like a buffalo than anything else he had ever seen. The little three-year-old child, Gretchen, who, on seeing the deer in the park contentedly lying in the shade of the trees, noticing them more especially in the act of chewing their cud, and asked, "What in the world do deers chew gum for?" evidently interpreted what she saw in light of her own experiences with "tutti-frutti." This same child, until two years old, had been accustomed to sleep with a light burning in the bedchamber. Thoughtlessly, the light was extinguished one night, after she had gone to sleep, without anything having been said to her about it. In the night she awakened, and in a frightened way excitedly called out "Oh, Papa, I've lost my eyes! My eyes are gone! Oh, do help me find my eyes!" You see the sensation of darkness she experienced could be interpreted only in light of her previous sensations. Before, when she awakened in the night and made an effort to see she was abundantly rewarded with success. This time she made the same effort but could not see, therefore, she concluded that her eyes were gone, since the sense of effort as clearly experienced now as before, was connected with no resulting sensation of vision. She could not be persuaded that her eyes were intact until the lamp was again lighted and the whole matter explained to her, notwithstanding the unseasonableness of the hour, at least so far as psychological explanations are concerned. Another little girl who said she "hugged dolly tight so the cats wouldn't frighten her with their horrid noises" surely remembered something of her own sensations of fright. The boy who bats the ball and tells by the "feel of the bat" whether it is a fair hit or a foul, bases his judgment on muscular sensations previously experienced.

There is no gainsaying the fact that all education naturally begins with the education of the senses. Of course the child, on entering school is one-sided in his development. For example, his eye may have been developed at the expense of his ear. The child reared in the tenement house could possibly have no such eye development as the child of the same age who has had the advantages of roaming over the hills, along the brooks and through the woods of the country. If, in our educational methods, we would, as teachers, pay especial and almost exclusive attention to the proper development of the senses, we would find that the motor impulses and resulting movements would take care of themselves, developing right in line with the corresponding sense development. *If the infant experiences no sensations it will never move.* The child is right-eyed before it is right-handed. Sensory paralysis will always cause motor paralysis. Educate the senses and the coördinate movements educate themselves.

One other point—even if it be a diversion, it is an observation that should be given at least a passing thought—we all admit that it is worse than a waste of time to read an effusive poem on "The Sunset" to a person always blind; and yet oftentimes in our teaching we do what is worse—we use words that convey no definite meaning to the would-be learner because they are not founded on any sensory experience. Children in entirely new experiences frequently base their judgment on previous experiences even if they have been gained through some other avenue of sense. The child sees an article of food which it has never seen before. It knows nothing of the taste and judges whether it will like it entirely on the basis of whether it is pleasing to the eye or not—its judgment being visual judgment rather than a taste judgment. To some children a given dish, such as fruit or berries, will not *taste* sweet unless the sugar can be seen. The gaily colored striped candy of the corner grocery is more the object of the child's fancy than plainer, more healthful confections would be, for it appeals to his child-eye as well as palate. Whatever attractions the red lemonade of the traveling circus has for the average urchin must be based on visual rather than gustatory sensations. A little boy who had never heard the croak of a frog described the sound as "That little round noise."

The brain processes with which sensations are always connected, are produced, then, by nerve currents, coming from the periphery of the body. As already stated, some external object must excite some one of the various end organs of sense before the sensation can possibly arise in consciousness.

You see, then, that four antecedents must precede each and every sensation:

First. An exciting cause—the stimulus producing changes in end organs of the sensory nerves.

Second. The action of this cause upon the nerves by means of the end organs. The "ether waves" that never reach the optic nerve, produce no visual sensations.

Third. Some sort of transmission to the brain centers by means of the nerve fibers.

Fourth. Activity of some sort within the brain center itself.

In order to have light from the incandescent electric lamp one must turn with his finger the switch or key, in order to allow the current to pass to the platinum wire within the vacuum globe of the lamp. If this could be accomplished in some other way the result would be the same—a light of so and so much candle power. So the function of the nerves is really to bring about changes in the brain center. If these brain centers can be incited into activity by any other means (a mechanical jar or changes in the quantity and quality of the blood supply) you have the sensation existing just as truly as if the impulse had originated at some outer end organ and been conveyed by some nerve to the brain.

It must be remembered that nerves as nerves do not differ from each other. [illegible] which [illegible] gives rise to a sensation of sound, is, as a nerve, not one whit different from the nerve that brings to us the sensation of smell. The specific differences in the various sensations are not due to any difference in the several nerves conveying the impressions, but due rather to differences in the end organs of sense. That the optic nerve conveys visual, and the ear auditory impressions, is due to the fact that the eye is different from the ear rather than that the optic nerve is in any way different from the auditory nerve. On the other hand, "If," as Professor James says, "we could splice the outer extremity of our optic nerves to our ears, and that of our auditory nerves to our eyes, we should hear the lightning and see the thunder, see the symphony and hear the conductor's movements."

Sensations are, as has already been said, the immediate results of nervous excitations entering the brain. Were there no such impressions, no such neural excitations, there would never be any brain activity—it would be plunged in deep sleep and midnight darkness, and consciousness could never arise. That we have different kinds of sensations is due to the different kinds of end organs of sense. We shall now discuss the various sorts of sensations which we experience in common, beginning with the sensations of

TASTE.

The end organs of taste consist of the so-called "gustatory bulbs," or, as some designate them, the "gustatory knobs" or "gustatory flasks." The latter term is probably the most suitable name, since it best indicates the shape of these minute end-organs of the taste sense. These little flasks are scattered somewhat irregularly over the tongue, palate and epiglottis, but are most thickly clustered in the little papillæ, or ridges found on the surface of the tongue. Without these little gustatory flasks no sensations of taste are possible, no matter if every nerve leading from the tongue and inner surface of the mouth is in a normal condition. These bulbs or flasks are so constructed that *only fluids can be tasted.* Solids and gases must first be reduced to a liquid state before sensations of taste can possibly be ex[illegible]enced. Only four qualities of taste can be designated with thoroughgoing certainty. They are—sweet, sour, bitter, and salt. Some of you may be quick to add a multitude of tastes which we distinguish in our food—*e. g.*, the taste of a banana, pear, onion, peach, and potato. But in such cases what we designate as taste is not taste at all. It is really smell. It is not the sensation of taste that makes the strawberry such an edible fruit but really a sensation of smell. The intimate connection of taste with smell is seen in cases where the impairment of the sense of smell by disease or a bad cold destroys or seriously modifies the ability to taste. Some foods in being masticated or swallowed are vaporized in the back part of the mouth and thence reach the cavity of the nose where this vapor product is smelled. The sense of taste pure and simple, does not admit of many varieties. It is extraordinarily limited in this respect. To take an example, the numberless acids of chemistry all arouse but one sensation of taste—sour—which varies only in intensity. A solution of quinine in the proportion of 1:100,000 cannot be distinguished from a solution of morphine in the proportion of 1:3,000. The bitterness of the quinine solution is like the bitterness of the morphine solution.

That much of what is ordinarily called taste is really taste plus smell or touch or both can be substantiated by a very simple experiment. With the eyes closed or blindfolded, and the nostrils held so as to cut off sensations of smell you will find it absolutely impossible to distinguish, by taste alone, the difference between small quantities of scraped apple and scraped potato when placed on the tongue.

The minute flask-like organs that perceive the various tastes are in a measure grouped together; those that perceive bitter by themselves, those that perceive sour in another locality by themselves. For example, the sensations of bitter generally, if not always, come from the root of the tongue, while sweet and sour are tasted with the tip of the tongue and the salt at the side edges. Nearly all substances, even sugar, will evoke a bitter taste when applied solely to the root of the tongue.

It has been found that sensations of the taste may be arou by electrical stimulation at different portions of the tongue and palate as well as at the epiglottis. If you use a constant current and two electrodes—one above and the other under the tongue—you will observe a sour taste at the positive pole of the current and an alkaline-like taste at the negative pole.

The sensitiveness of the organs of taste are much more acute than we are apt to think. The work done a few years ago by Bailey and Nichols in experimenting with reference to the minimal tastes that can be perceived, is well known and very interesting in this connection. These two investigators made the observations upon 128 persons, whose ages ranged from twelve to fifty years. Of this number 82 were men and 46 women. Bitter, sweet, acid, alkaline and saline were regarded by them as the fundamental and representative tastes, and solutions of substances were used in order to test the discriminative ability of the taste-organs—or, rather, to test the organs with reference to minimal tastes. The substances selected were as follows:

1. Bitter—Quinine bisulphate.
2. Sweet—Cane sugar.
3. Acid—Sulphuric acid.
4. Alkaline—Sodium bicarbonate.
5. Saline—Common salt.

The results obtained were these:

I. QUININE.
  Men detect one part in 390,000 parts of water.
  Women detect one part in 456,000 parts of water.

II. CANE SUGAR.
  Men detect one part in 199 parts of water.
  Women detect one part in 204 parts of water.

III. SULPHURIC ACID.
  Men detect one part in 2,080 parts of water.
  Women detect one part in 3,280 parts of water.

IV. BICARBONATE OF SODA.
  Men detect one part in 98 parts of water.
  Women detect one part in 126 parts of water.

V. Common Salt.

Men detect one part in 2,240 parts of water.
Women detect one part in 1,980 parts of water.

It is seen from the above that as a rule the sense of taste is more finely developed in women than in men. The exception to this rule is the case of common salt. While this is the rule with respect to the sense of taste, Maggiori and Mosso have found that in general the senses are more acute and delicate in men than in women.

Of course, you cannot compare extreme sensibility for one sort of taste with that for another taste. From the table given you you might be inclined to argue that the sense organs of taste are better developed for bitter than for sweet; but you can hardly do this because you cannot say the quinine is as bitter as the sugar is sweet, or the lemon is as sour as a particular substance is salt, any more than you can say that the rose is as red as the buttercup is yellow, or that the sky is as blue as a noise is loud.

Sensations of taste may be greatly modified or even obliterated when the temperature of the end organ of taste is extremely warm or cold. Fill the mouth with hot water, hold it for a moment, then expel it. Immediately after, place a little salt or sugar on the tongue and you will find that the usual sensations of taste are not experienced. If you take a small piece of ice into the mouth and hold it near the root of the tongue you will find that quinine, if placed in the same locality, will give rise to no sensation of bitter as is ordinarily the case.

SMELL.

The sense of smell is possessed even by some of the lower animal forms. A blinded starfish can scent a crab (its chosen article of diet) at quite a considerable distance. The shark is entirely dependent upon the sense of smell. Destroy this sense and the shark will refuse to eat though he can see ever so well. The feelers of many insects are in reality organs of smell. Certain organs of smell exist in the outer extremities of the antennules of crabs.

In all vertebrates the end organs of smell are found in the *olfactoria* of the nose, which consists of a mucous membrane covered with a layer of cells, and these cells give off certain hair-like processes. The smell apparatus is a very simple contrivance. All that is necessary is that a current of air, in which stimulating particles float, be drawn through the nose over the mucous membrane of the *regio olfactoria*. The strongest substances, such as ammonia and camphor, even when placed directly under the nostrils, have no smell as long as the breath is held, or inhaled through the mouth instead of the nose. We seldom smell in exhaling, because in expiration the air does not pass so directly over the olfactory regions as in inspiration. The end organs of sense and smell are very easily fatigued. If you hold a piece of camphor gum to the nose and smell of it continuously, inhaling through the nose and exhaling through the mouth, you find after a few minutes that a very marked decrease in the intensity of the sensation will be noticed extending even to entire loss of the ability to perceive the odor for the time being. It must be added that fatigue for one substance does not necessarily involve fatigue for all others. Smell of some essence of cloves, then of some ordinary yellow beeswax, and then fatigue for camphor as above. If you then smell of the wax and essence of cloves again, you will in all probability find that the odor of these two substances is unaffected.

Smells do not really admit of classification. The classification sometimes made use of—namely, pleasant and unpleasant smells—has no real basis, for it depends entirely upon individual peculiarities; as Professor Ladd remarks, "to some the smell of burning feathers, of assafœtida, of valerian or of rank cheese is pleasant." Speaking of the possibility of classifying smells Dr. Porter tells us that—"Their varieties are almost endless. The odors from flowers, from food, from perfumes, from woods, from earths, from metals and from many other objects, are too numerous to be classed or named except in a very general way. We *class* them in a few general and obvious groups, as quickening, refreshing, depressing, sickening, aromatic, spicy, etc., etc. We name them usually from the objects which excite them, as the odor of the violet and the lilac, of the rose and the tuberose, of the peach and the apple, of cedar and camphor-wood."

The minimum stimulus for the end organs of smell is very small for a large number of substances. For example, $\frac{1}{2000000}$ part of a milligram of an alcoholic solution of musk is perceptible, likewise $\frac{1}{460000000}$ of a milligram of mercaptan is sufficient to produce a sensation of smell.

In paralytics both the senses of smell and of taste are usually disturbed. Kornfeld and Bikeles have made a large number of experiments in this line, and find that with reference to the sense of smell, it was noticed that certain paralytics could not recognize the odor of onions, caraway-seed, or vinegar. One patient mistook the odor of an onion for that of a lemon; and the same patient could not recognize the odor of garlic; while another called the odor of vinegar that of ordinary whisky.

The sensations of taste in these paralytics were experimented upon chiefly by means of standard solutions. The following were some of the results: At the tip and sides of the tongue the patients appear in general to have no correct sense of taste. For example, the patient would designate a 4-per cent. solution of salt as sour. "Salty" and "sour" could not be distinguished from each other, for the salt solution above referred to was frequently designated as sour, and a citric-acid solution as salty. Even quinine bisulphate was regarded as sweet, sour, or salty interchangeably. At the root of the tongue the following results were obtained. A 4-per cent. solution of sugar was perceived as tasteless, while an 8-per cent. salt solution was designated sour. In experiments with this latter solution, if the patient were permitted to roll his tongue and draw it back, he would then sometimes designate the taste as slightly salty; others would say that the 2-per cent. solution of citric acid tasted the same as the 8-per cent. solution of salt; still another characterized as bitter this same citric-acid solution.

When applied to the gums, sour and salty substances were most frequently regarded as bitter; while an 8-per cent. solution of quinine, on the other hand, was not perceived as bitter, but rather as acid and astringent. When permitted to swallow this strong solution, they would experience a slightly bitter taste.

Much more important to the Psychologist than the sensation of smell or taste are the various sensations of feeling in the *skin*. The dermal senses comprise the temperature sense, the pressure sense, the tickle sense and the tactile sense proper. It must be remembered in this connection that sensibility of the skin is the first sense that appears, and the one from which all others have probably been developed by gradual steps and stages in the process of evolution. The eye, ear, *regio olfactoria*, etc., may be regarded as highly differentiated portions of the skin. The sense of sight is at first a generalized property, many Protozoa showing themselves sensitive to light. In the Hydroids, even in the fresh-water species, we have a good example in that many single cells with direct muscle connections are found scattered all over the dermal surface, and are sensitive to light.

LESSON IX.

SENSATION (CONTINUED).

THE TEMPERATURE SENSE.

It is an important fact to remember that the nerves are not different from each other. The sensory nerves as nerves are anatomically, structurally and functionally alike. But some nerves convey to the brain only sensations of heat, others only sensations of cold, while others carry to the brain only sensations of touch or simple contact. These differences are not due to differences in the nerves themselves, but are due to specific differences in the end organs with which they are connected. Magnus Blix has shown that upon some one spot of the skin only cold may be perceived, upon another only heat, and upon a third spot only sensations of touch or simple contact. This is due to the fact that the different sorts of terminal organs are found in different localities on the skin. One locality may abound in heat spots while another portion may abound in cold spots, as the back of the neck. We have, therefore, as end organs of sense in the skin itself, the "heat spots," "cold spots," "pressure spots" and "tactile corpuscles." Stimulate any one of these end organs and you evoke a corresponding sensation. You cannot get the sensation of heat by stimulating a cold spot any more than you can get a sensation of sound by stimulating the eye with light. We can easily convince ourselves of this important fact by applying the cold point of a lead pencil, or better, the point of a steel rod here and there on the forearm. After a little such exploration you will find a locality at which no sensation of cold will be received from the cold point, although a sensation of heat will appear if only the proper stimulus be applied. Close beside this spot you will find other localities that are acutely sensitive to cold, though no sensations to warmth or touch can there be perceived. You conclude, therefore, and rightly, too, that there are separate spots for perceiving heat, cold and touch, and each nerve fiber leading from these particular spots can transmit but one kind of sensation. The skin can be pretty well mapped out with reference to these end organs of sense, especially with reference to the heat and cold spots.

These two kinds of temperature spots respond with their characteristic sensations, to both mechanical and electrical stimulation. If you select a well located cold spot, for example, on the back of the hand or the volar side of the index finger, and allow another person to tap it with an ordinary wooden toothpick, you will find that a distinct sensation of cold arises. It is also a singular fact that these temperature spots give no pain when punctured, as may be substantiated by thrusting a needle into a well-located cold spot.

These temperature end organs respond also to chemical stimulation. Take the temperature of the skin on the back of the hand by allowing a thermometer to remain in contact with it for some little time. Write down the temperature for the purpose of comparison later. Then take a menthol pencil (such as is used to relieve the headache and which can be purchased at any drug store) and rub the skin with it. You experience marked sensations of cold, because the menthol has chemically stimulated the cold spots, but you find if you again take the temperature of the skin with the thermometer it is actually higher notwithstanding the contrary sensation of cold which you so distinctly feel.

Furthermore, the intensity of the temperature sensation depends upon the amount of dermal surface that is stimulated. If, for example, you dip a single finger in cold water and immediately afterwards the whole hand, you will observe a marked increase in the intensity of the sensation of cold.

The feeling of temperature is relative to the state of the skin. In a comfortable room at no part of the body do you feel heat or cold, although, as physiologists tell us, the different parts of the bodily surface are at different temperatures. Thus the fingers and nose are cooler than the trunk of the body, and the trunk cooler than the interior of the mouth cavity. That degree of temperature at which a given locality has the sensation of neither heat nor cold is called the *zero-point* for that locality. This zero-point is not only different at different parts of the body, but is also a variable with reference to the same part from time to time. On passing from a room of a given temperature into one whose temperature is higher or lower we experience at first sensations of warmth or cold while our "zero-point" is becoming adjusted to the new environment. Of course the determination of the exact zero-point of different parts of the body is an exceedingly difficult affair, being purely a relative and not an absolute quantity. It has been shown that if the hand be held for a minute in the water of the temperature of 54° and then in water 64° (Fahrenheit), a sensation of heat will be felt for a few seconds, although the latter would have felt cold to the hand if placed in it at first. You have noticed perhaps, when indulging in fruit ices or ice cream that cold drinks such as ice water and lemonade taste warm because the zero-point of the mouth is for the time being very low. No matter what the zero-point may happen to be, it is always found that the skin is most sensitive to such changes of temperature as lie near its own zero-point.

SENSATIONS OF PRESSURE AND SENSATIONS OF CONTACT

must, from the nature of the case, be treated together.

Just as there are heat and cold spots distributed over the skin, so we find that certain nerves terminate in what are called pressure points or pressure spots, meaning those points at which a clear feeling of contact will be perceived when appropriately stimulated. Through these little corpuscles we recognize pressure, and the resistance of bodies as well as the softness or hardness, the roughness or smoothness of the object causing the sensation. We find that the delicacy of the sense of touch varies at different portions of the skin. It is the greatest on the forehead, temples, back of the forearm, and eyelids, where an exceedingly small weight can be distinctly perceived.

The size of the object, or better, the amount of dermal surface stimulated, plays an important part in our judgment of pressure on the skin. If two bodies of equal weight and unequal size be placed at some convenient locality on the skin, for example, the palm, one after the other, it will be found that the smaller of the two will seem decidedly the heavier.

Our sensations of pressure are greatly modified by the temperature of the object used as a stimulus. Cold or hot bodies feel heavier than bodies of equal weight at a normal temperature. If, for example, you take two silver dollars, warming one until it has gained the same temperature as the zero-point of the skin, and therefore ceases to seem cold, then cool the other to about 12° centigrade, and apply these one after the other to the palm of the hand, you will find that the cold one will seem much heavier, even as heavy as two at the normal temperature. If you take two small wooden cylinders about one inch in diameter and one and one-half inches long, and heat one (keeping it dry) till it is quite hot, the other remaining at the normal temperature, it will be found that the hot one will seem the heavier when the two are placed alternately (standing on end) on the back of the hand.

When pressure is evenly distributed over a considerable area of the skin, it is found that it is less strongly felt than pressure upon a small area which is bordered by one that is not pressed. When the hand is immersed, for example, in water, or better, mercury, you will notice that the sensation of pressure is strongest in the ring about the wrists, that is, it is felt only at a line along the surface of the liquid where the immersed and non-immersed portions of the skin meet. This ring effect is more pronounced when the hand is moved up and down in the liquid.

The fineness of the pressure sense is very remarkable. Scarcely any other sense will educate so rapidly and to such a degree of acuteness. You may judge something of its powers in this direction by observing that the slightest unevenness of surface may be detected by the sense of touch alone. Suppose you try this simple experiment: Place a hair on a plate of glass or an ordinary dinner plate, or any hard, smooth surface, and over it lay ten, twelve, or fifteen sheets of writing paper. The position of the hair on the plate can be easily detected by passing your finger tips back and forth over the surface of the upper sheet of paper.

When the eyes are closed and a point on the skin is stimulated we can pretty well indicate the locality which has been touched, yet by no means *exactly the same place.* Have a friend close his eyes, touch him on the forearm with a pencil-point and require him to touch the same place with another pencil-point immediately after. You will find that he will make an error which you can measure with an ordinary graduated ruler, and you will also observe that the errors are generally constant in following a given direction. The accuracy of the localizing power varies widely at different localities on the skin. You can test the localizing power within a given locality by using ordinary compasses or dividers, the points of which are blunted or tipped with small bits of cork to avoid the sharpness and coldness of the metal. Find the least distance apart at which the two points of the dividers can be recognized as two when applied to the skin. The average that must intervene between the two points in order that they may be felt as two is as follows for various localities, the experiments having been made several years ago by Weber:

Tip of tongue	.04 inch
Palm side of the last phalanx of the finger	.08 inch
Red part of lips	.16 inch
Tip of nose	.25 inch
Palm side of the second phalanx of finger	.28 inch
White of lips	.36 inch
Cheek	.44 inch
Heel	.88 inch
Forehead	.92 inch
Back of hand	1.23 inch
Knee-pan	1.44 inch
Forearm and lower leg	1.58 inch
Nape of neck	2.11 inch
Middle of back, upper arm and thigh	2.75 inch

When several touches occur simultaneously, it is found that there is still more confusion in locating the stimulations of the sense of touch. It might be interesting in this connection to sum up the results of about twenty-five hundred experiments, which I recently made on the fifteen different persons at different times.* The endeavor of this study was (1) to discover the relative sensitiveness of different portions of the skin; (2) to find the nature and direction of the errors in localization; (3) to study the influence of attention upon the localization and interpretation of sensations when they occur simultaneously; (4) to examine the effect of practice. Can the skin be educated to greater sensitiveness and accuracy in localization?

There is not sufficient space to describe in detail the method of experiment and apparatus employed. Many interesting results were gained, among which the following are the most important.

First. Indubitable evidence as to the relative sensitiveness of the skin.

(a) Skin over the joints is much more sensitive than that of other localities on the dermal area. Touches on the joints are always more correctly localized than any other.

(b) Touches on the back of the body are more distinctly felt, more clearly located, and therefore better localized than those on the front part of the body.

(c) Localization of these touch sensations is better for points not on the median line than for those that are. When touches occur on the median line of the body but 34 per cent. are correctly localized, while at other localities 68 per cent. are accurately located.

(d) On the left side of the body we do not localize touches so correctly as on the right side, that is if we are right-handed.

(e) On hairy portions of the skin the localization is better than on those portions not covered with hair. This is especially noticed when the hairs have been shaven, as in one instance the skin over the thighs and calves (after the shaving of the hairs) was so sensitive as to vitiate the experiment, because the sensations received at these localities were so intense and pronounced as to cause the mind to lose track of the sensations at the other stimulated portions of the skin.

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* These experiments are described in detail in the *Journal of Nervous and Mental Disease*, New York, March, 1893.

(f) The parts usually covered with clothing do not localize so well as those not usually so covered.

Second. The nature and direction of errors in localizing touches. Out of every 100 errors in localizing touches in these experiments 42 per cent. were errors of extension; that is, errors in which the touch was located at a point nearer the extremities of the limbs than where the touch actually occurred. To illustrate, a person is touched on the forearm just below the elbow; if he make a mistake at all he will locate the touch lower down on the arm near the wrist, rather than at some point above the place actually touched. The average amount of such "extension" errors was 4.36 inches.

Third. Attention plays a most important part in the localization of these touch stimulations.

Fourth. The effect of practice is very marked.

Fifth. Fusion of stimulations into one touch sensation. Two or more touches are often fused into one single sensation, and this one sensation localized at a point quite removed from either of those at which the stimulations were actually received. For example, two touches, one at the top of the right shoulder and the other at the tip of the right shoulder blade were quickly fused into one sensation, localized as coming from a single point midway between the two places actually touched.

Sixth. Diffusion. There were also results diametrically opposed to the case of fusion just cited. Thus one subject, being touched by a *single* cork at a point directly under the armpit, indicated that he had been touched at *two* localities about four inches apart, *when there was really but one point touched.*

A general rule might be laid down; it is this: *The localizing power is delicate in proportion as the skin covers a more movable part of the body, and is also more acute when the pressure stimulation is just strong enough to cause an appreciable sensation than when it is more powerfully impressed.*

Mr. H., who, in the fall of 1892, was the "coach" of a university foot-ball team, had his left forearm broken in a hotly contested game while playing with his eleven against that of another institution. The surgeon who was called did his work in such a bungling manner that after the bones had begun to knit the arm had to be broken over again in order to set it properly. To keep it in the correct position a plaster cast was made which held it firmly. This plaster-of-paris case extended from the knuckles to a point above the elbow. After three months the case and bandage were removed. Of course during the entire period when incased in the plaster, the forearm had not been moved either at the wrist or elbow. I then endeavored to test the sensibility of the skin on this arm which had not been moved for so long a time. To do this, I applied the points of a pair of dividers or compasses which were separated more or less widely as mentioned in certain experiments above. The forearm was divided into four different areas for purposes of more accurate comparison with the sensibility of the skin on the uninjured right forearm of the same person. Without going into detail, it should be stated that on the left forearm—the one so long immovable, when the two points touching the skin at a given region were separated by as much as 55 millimeters they were felt as one instead of two, while on the right forearm at the same place they would only have to be about 20 millimeters apart in order to be perceived as two. On the back of the "lame" arm at a different locality than that just mentioned, it was found that even when the two points of the dividers were 75 and 80 millimeters apart, they were felt as *one*, while at a corresponding locality on the right arm the skin was so sensitive that points but 17 millimeters apart would be felt as two. It must be also observed that this particular person had always previously been, with reference to a large number of activities, practically ambidextrous—indeed, he never had to favor the left arm at all. In his position as gymnasium instructor he could (before the accident) manipulate the dumb bells, Indian clubs, play base ball, hand ball, and the like with the left hand just as *well as with the right*. It would seem, then, that the sensibility of the skin over the injured forearm was lost simply because that member was for so long a time necessarily immovable. This has an important bearing on the above-mentioned principle, to the effect that "the localizing power is delicate in proportion as the skin covers a movable part of the body."

Again, filled space is as a rule underestimated by the skin. A solid line, like the back of a knife-blade, will feel shorter than several points arranged in a similar straight line of the same length as the solid line. An interesting experiment for you to perform is to take a small wooden rod and stick into it a straight row of five pins separated from each other by one-half of an inch. In another such a wooden rod set up two pins one and one-half inches apart. Apply them to the arm one after the other. You will find that the two inches of space occupied by the five pins will seem less than the one and one-half inches between the two pins.

We are also subject to great confusion in our judgment of motion on the skin. If you select a convenient area on the dermal surface—the forearm, for example—and move a pencil-point over the skin, you will observe that you can tell that the point is moving before you can tell the direction in which it is moving. A common and persistent illusion somewhat related to the above experiment may be experienced if you touch the forehead with the index finger (keeping the finger motionless) and move the forehead from side to side; you will find that the motion will be attributed to the finger rather than to the forehead. This is an irresistible sensation of which one cannot rid himself. Perhaps you have already tried the old-time experiment of Aristotle, in which you merely cross the middle finger over the index finger in such a way as to bring the middle finger on the thumb side of the index finger. Inserting between the two a pea, bullet, or other small object, you perceive a more or less distinct sensation of two objects instead of the one actually present.

Furthermore, you will always find that active touch (touch with movement) gives quite a different sensation than mere simple contact or passive touch. It is also more discriminative. The carpenter who desires to tell whether the board is planed smoothly or not, does not simply lay his hand on the board, but rubs it over the surface, the smoothness of which he desires to judge. Likewise as to the grinder of lenses for optical instruments. Compare for yourself the sensation received from merely resting the tip of the finger on the rough surface of a piece of sandpaper, or even a rough book cover, with the sensation you receive when you move the finger over such a surface. The bank teller cannot tell a counterfeit five-dollar bill or the spurious lead coin by simply touching it passively. He rubs it between his fingers, or rubs his fingers over it. The merchant in buying cloth depends largely upon the "feel of it," as he rubs it between his thumb and finger to determine the quality of its texture. You probably do the same thing in comparing several varieties of writing paper as to their smoothness and thickness.

Sergi, the Italian Psychologist, and others have made some extended experiments with reference to ascertaining the acuteness of his skin's power in making time discriminations when a number of stimulations follow in close succession. In other words, his attempt was an endeavor to find how much of an interval there must be between successive touch stimulations to prevent their being fused into one continuous sensation. As apparatus he used six tuning forks, each of which could be set into vibration electrically, and which were, respectively, capable of 30, 100, 250, 435, 500 and 1,000 vibrations per second. Various locations on the skin are then brought into direct contact with each of these forks after they are set into vibration. After a large number of careful tests, Sergi finds that different portions of the dermal surface are by no means equally capable of perceiving successive stimulations and of making time discriminations. He did find some localities exceedingly sensitive — *e. g.*, the tips of the fingers where the beats of the fork do not blend into a continuous sensation of touch, even when the vibrations are 1,000 or more a second.

LESSON X.

SENSATION (CONTINUED).

THE MUSCLE SENSE.

By muscular sensations are meant all those sensations which arise from the varying condition of the muscles whether in action or at rest; therefore they depend upon the contraction and relaxation of the muscular fibers or the varying relative position of the muscles. When we slowly stretch or violently jerk the arm, when we snap the finger, when we rotate the wrist, when we tread or kick with the foot, when we strain and tug with the whole body to lift a heavy weight or push against a resisting obstacle, we experience a corresponding variety of muscle sensations.

The muscle sense is among the first, if not itself the very first, to furnish data by means of which the child becomes able to distinguish himself—his body—from the rest of the material universe. Through a large variety of movements the infant first explores every part of the organism, and as a result derives that standard by which he measures the material world without. You see, then, by the expression "muscular sensation" is meant those feelings of which we are conscious when we voluntarily exercise or refrain from exercising our muscles.

While the real muscular sensations would comprise those of pain, effort, fatigue and the like, it should be observed that the term "muscle sense" has come to receive a more restricted, definite and special meaning in Psychology, and it is now used to designate more particularly that sense by which lifted weights are perceived. For experiments upon sensations belonging to this class, it is necessary to have a series of weights for the purpose of testing one's discriminative ability with reference to this special sense. The most available weights for such purposes are made by loading paper gunshells with shot. A convenient series would consist of the following weights: 100, 101, 102, 102.2, 102.5, 103 and 103.4 grams. Also a carefully graduated series of smaller weights beginning with a weight of ten grams, and running as high as fifteen grams. The experiment should be made something as follows: Let the person whose discriminative ability for lifted weights you wish to test, stand at a table of convenient height. He should be blindfolded. Place within easy reach of his right hand and near together two weights, one of which should be the standard weight of 100 grams, and the other a weight to be compared with it, either one that is equal, heavier or lighter. Let the subject lift them one after the other, being careful that he lift them the same way, to the same height and at the same rate, giving a decision as to which of the weights he thinks is the heavier or the lighter. If he thinks the two of equal weight, record this judgment also. The fact of the matter is that when the two are of equal weight he will be apt to say that the second one lifted is the heavier. The difference between the two weights must be considerable if it is to be perceived. If we should close our eyes and a friend should lay a weight of 300 grams, then one of 312 grams, on our hand and we are called upon to state which of the two is the heavier it would be seen that the additional weight of twelve grams more than the original 300 grams is so small that the difference is not constantly perceived with thoroughgoing certainty. Fechner, the first to innovate this test, found that in one hundred such trials as the one just indicated, in which sometimes the lighter and sometimes the heavier weight was first lifted, the correct answer was given sixty times. Therefore the number of correct cases amounted to 60 per cent.

Now a second series of trials is made, the initial weight being 600 grams, the additional weight remaining 12 grams for the time being. It is then soon found that the number of false estimates has been greatly augmented, the number of correct cases being not more than 40 per cent. In order to attain 60 per cent. correct cases, as in the case of 300 grams and 312 grams, we to raise the additional weight to 24 grams if our initial weight remain 600 grams. If the beginning weight is doubled, the additional weight must also be doubled in order that the probability of a correct discriminative judgment remain constant.

Closely allied with the muscular sensations are what is known as the *organic sensations*. When the stomach, lungs, heart and other visceral organs are entirely healthy and their functions are normally performed, they are attended with no very positive or distinct sensations. If, however, they be injured or diseased, very clearly recognized disturbing and unpleasant sensations result. The hale, hearty, healthy man does not know that he has a stomach; the dyspeptic person hardly knows that he has anything else. These organic sensations are often blended with the muscular, and are experienced in constant connection with normal or abnormal muscular sensations.

But more intimately related to the muscular than are these organic sensations are those of the *joints and tendons*—sensations, which are often experienced in the passive motion of the various bodily members, especially brought into prominence in the flexion of the elbow. The surfaces of the joints are organs which become intensely painful when the least bit inflamed. The motion of the articulated joints upon each other gives rise to a peculiar sensation. To this sensation is due the perception we have of the position of our limbs at a given moment. If these joint surfaces are rendered anæsthetic the perception of the movement, and consequently the position of the limbs, becomes exceedingly obtuse. If you place the forearm of a person flat upon a hinged board and raise one end of the board so that the forearm is slowly and gradually elevated, and require the person to pronounce when he first perceives the motion of his forearm, it will be found that the chief data upon which he bases his judgment is the peculiar sensation of motion which he localizes in the elbow joint. At least this is what happens with healthy persons in normal condition. But when the feelings of such passive movements as well as other sensations which furnish us a clue to the position of our limbs are lacking, we get such results as are related by Professor Strümpell of his wonderful anæsthesic boy, whose only sources of sensation were the right eye and left ear. The principal features of the case are thus quoted by Professor James:[*] "Passive movements could be imprinted on all the extremities to the greatest extent, without attracting the patient's notice. Only in violent forced hyperextension of the joints, especially of the knees, there arose a dull vague feeling of strain, but this was seldom precisely localized. We have often, after bandaging the eyes of the patient, carried him about the room, laid him on a table, given to his arms and legs the most fantastic and apparently the most inconvenient attitudes without his having a suspicion of it. The expression of astonishment in his face, when all at once the removal of the handkerchief revealed his situation, is indescribable in words. Only when his head was made to hang away down he immediately spoke of dizziness, but could not assign its ground. Later he sometimes inferred from the sounds connected with the manipulation that something special was being done with him. . . . He had no feelings of muscular fatigue. If, with his eyes shut, we told him to raise his arm and keep it up, he did so without trouble. After one or two minutes, however, the arm began to tremble and sink without his being aware of it. He asserted still his ability to keep it up. . . . Passively holding still his fingers did not affect him. He thought constantly that he opened and shut his hand, whereas it was really fixed." Goldscheider found that a swing of the arm, amounting to .22° to .42°, is sensibly perceived in the shoulder joint. Such small displacements as these can hardly be detected by the eye. Of course the velocity with which the member is moved plays an important part. The minimum velocity for the shoulder joint has been found to be about .3° in a second of time. All these facts prove that the joint surfaces constitute the chief seat of the impressions by which the movements and position of our bodily members are immediately perceived.

Mention must also be made of the *sensations of resistance*. To demonstrate what is meant let us take a five-pound weight to which is attached a strong piece of ordinary string. With the arm extended hold the weight by the string so that it hangs just a few inches above the floor. Lower the weight rather rapidly until it strikes the floor. Just as it strikes, a sensation of resistance to further motion is clearly perceived.

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[*] William James. Psychology—Briefer Course. New York, 1892. The German account is not in our possession.

We now come to speak of those sensations by means of which we recognize *the position of the body as a whole.* That there are such sensations can be very easily verified by a simple experiment. The most clear demonstration occurs in connection with the "tilting board" shown in the cut. (See Fig. 17.) This consists of a board seven feet long and two feet wide balanced over a support somewhat resembling a sawhorse. At one end there is a footboard secure enough to bear the weight of a man when the tilting board is in a vertical position. At the other end should be attached a plumb-line and a semicircular scale so adjusted that the inclination of the tilting board can be read off at any moment. To pre-

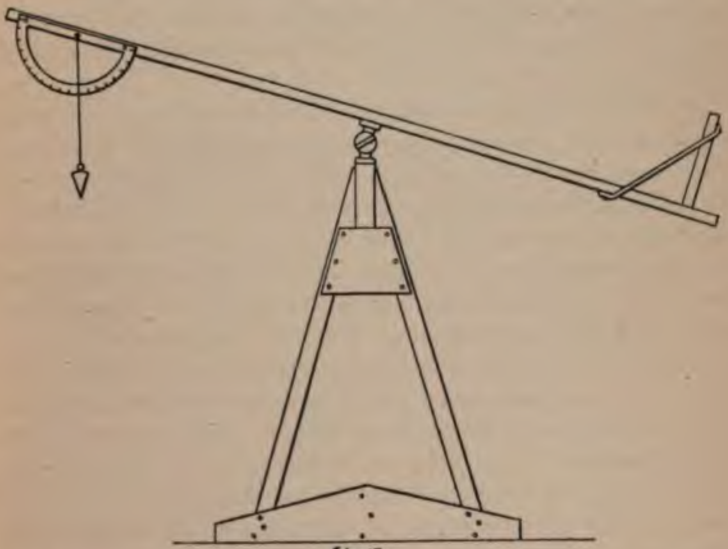

Fig. 17.

vent the person from falling when the head is downward, shoulder and body straps are provided which securely bind him to the board. Cause the person who is to serve as subject in this experiment to place himself on the tilting board and have him close his eyes. Begin with the board vertical, his head up. On questioning him you will find that he will probably announce that he is leaning slightly forward. Tilt him slowly backward and require him to announce when he is at an angle of 45° from the vertical, when at an angle of 90°, and when at an angle of 180°. In most cases the subject will probably say that he is vertical, head downward, when he is from 30° to 60° from the designated position.

In this connection reference must be made to the *sensations of rotation*. The nature of these sensations is also best determined by appeal to actual experiment. Some of these experiments can be performed by twisting the rope of an ordinary swing in which a person is seated. It is better, however, to have a board laid across a screw stool or ordinary rotating office chair without a back; seat the person and rotate him rapidly for about half a turn, then stop him suddenly. A distinct sensation of rotation in the opposite direction will be clearly perceived. This experiment must be performed with the eyes closed, for if the eyes be open, the sensation immediately ceases. Close the eyes again and it returns. When a person is turned in one direction and then in the other for quite a little period of time and for different distances, he will finally lose all knowledge of direction in which he is subsequently rotated. These totally wrong judgments with reference to the direction of rotation are quite common, and are made use of in a number of children's games. The "donkey game" is a familiar example. A figure of a donkey minus a tail is cut out of colored paper and fastened to a sheet or screen hung up on the wall at one end of a room. Each member of the company is then required to locate the proper place for the tail standing at he opposite end of the room with his eyes open. Then he is ndfolded, turned about by another person, first in one direc- then in the other, and finally told to pin the detached tail, which has been cut out separately, to the donkey at what he thinks is the proper place. Much merriment is caused by the striking mistakes with reference to direction and locality.

It ought also to be mentioned here that deaf and dumb persons are, as a rule, quite insusceptible of being made dizzy by rotation. The semicircular canals located in the labyrinth of the ear are, as it were, six little spirit levels, which seem calculated to be organs of the sense of rotation.

LESSON XI.

SENSATION (CONTINUED).

VISION.

THE organ of vision is the eye. It is not necessary in this place to give a detailed description of the structure of the eye. Such a description can be found in any book on anatomy. It is, however, always an interesting observation for one to verify such descriptions by dissection of the eye of a beef or sheep. For such examination the specimen should be first frozen or hardened in alcohol.

The following general points in reference to the eye's structure ought, however, be noticed in passing. With the exception of the ear, the eye is by far the most complicated end organ of sense. The eye is an optical instrument, with a self-adjusting lens, and supporting, on its inner circular wall, a delicate membrane of nervous matter which acts as the sensitive plate of the camera (for such the eye is) on which the image is formed. On examining the eye you find it to be a flattish sphere formed by an outer tough membrane which incloses a nervous surface and refracting media. The parts of the eye are shown in the schematic drawing of Gegenbaur (Fig. 18).

Of the three coats of the eye the inner one (retina) is by far the most significant. As stated above, it is the sensitive plate, and is a delicate membrane consisting of ten layers. Of these layers, the structure of the ninth (counting from the inner surface)—the layer of the rods and cones—is the most interesting. It consists of a multitude of elongated bodies arranged side by side in a sort of mosaic. These bodies are of two kinds; one, the cylindrical "rods," the others, more flask-shaped, are called "cones." The rods are longer than the cones. In the *adult human eye* they are about $\frac{1}{350}$ of an inch in length. It is a peculiar fact that these end organs are not pointed forward toward the light as it streams through the pupil, but backward toward the outer or sclerotic coat. The cones seem to be the most sensitive to light. Certain it is that in the center of the eye only cones appear, and they are exceedingly numerous, over 1,000,000 being found in a $\frac{1}{10}$ inch square.

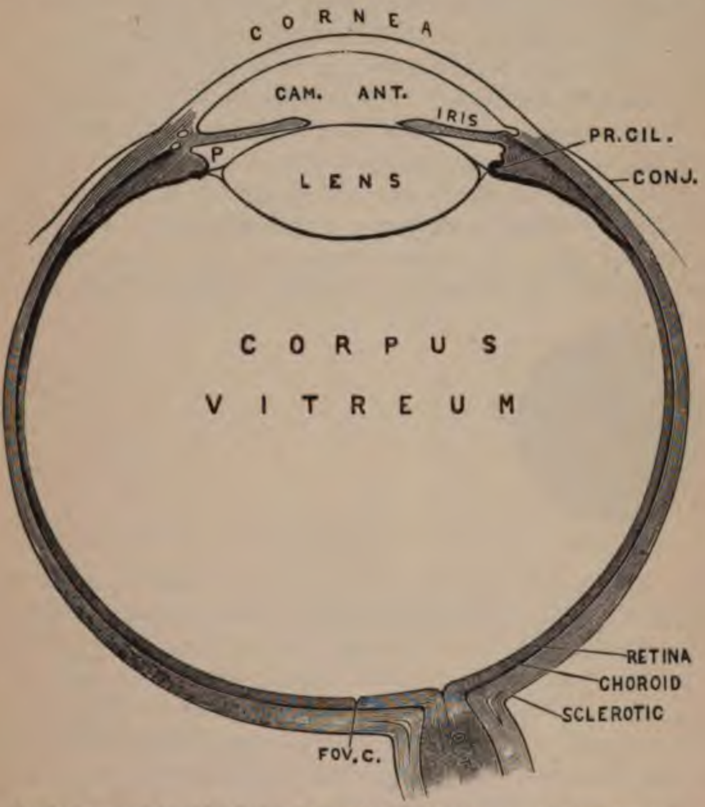

FIGURE 18.—Horizontal section through the left eye. $^4/_1$. (Schematic, from Gegenbaur.)

The optic nerve fibers cannot be directly stimulated by light. The place *on the retina* where the optic nerve enters the eye is in fact entirely blind, because nothing but fibers (and no rods and cones) exist there. This spot is wanting in all nervous elements sensitive to light. To prove the existence of the blind spot, close the right eye and look steadily with the left at the cross in Fig. 19, holding the book in front of the face, moving it to and fro. At about one foot from the face the black disk entirely disappears; when nearer than this or farther from the face it is seen. In this simple experiment it is absolutely necessary to keep the left eye focused on the cross. The blind spot is about $\frac{1}{13}$ of an inch long in the average human eye.

Aside from the blind spot the sensibility of the eye varies greatly. The place of clearest vision is the "yellow spot" which is oval in shape, with a central depression called the fovea. This yellow spot is about 1-16 of an inch in length and lies at a distance of 1-6 of an inch from the middle of the blind spot. As Dr. Sanford suggests, the yellow spot may be projected and seen in the following manner: Close the eyes for about thirty seconds and then look with one of them *through* a flat-sided bottle, containing a saturated solution of chrome alum, at the clear sky. In the blue-green solution of the chrome alum a rose-colored spot will be seen which corresponds to the yellow spot of the eye.

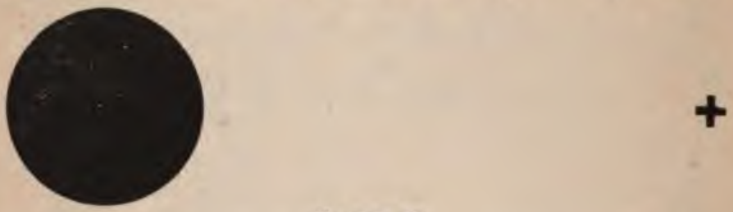

FIGURE 19.

We see single with two eyes, just as we hear single with two ears and smell single with two nostrils. We can, however, see double under certain conditions, though we can never hear double or smell double. An easy and clear demonstration of this fact is to roll a sheet of paper so as to have a tube an inch or two in diameter and a foot long. Keep both eyes open, and hold with your right hand one end of the tube to your right eye (with which you are to look *through* the tube) to restrict its field, and leave the left eye unrestricted as to its field of vision. Place the open left hand (palm side toward you) against the left side of the tube directly in the field of vision for the left eye. With both eyes look straight ahead. With your right eye you see the hole of the tube and with the left you see your hand. Your mind superimposes the image of the one on that of the other, consequently you see your hand with a hole in it just the diameter of the tube. Again, take the same tube and hold it over one eye and then with both eyes look at a finely figured wall paper or carpet. To the eye whose retinal field is restricted by the tube the object looked at will appear further away than it does to the other eye. Another interesting experiment in this direction would be for the reader to gaze fixedly at Fig. 20 with the black spots directly in front of the right and left eyes, respectively. After looking at it for a little time, as if the paper were at an infinite distance, or as if he were looking through it, the reader will see the two black dots fuse together and combine into one. This combined spot is located directly in front of his nose on a line between the two actual spots. This combined spot results from seeing the two spots in front of each eye with the same part of the fovea.

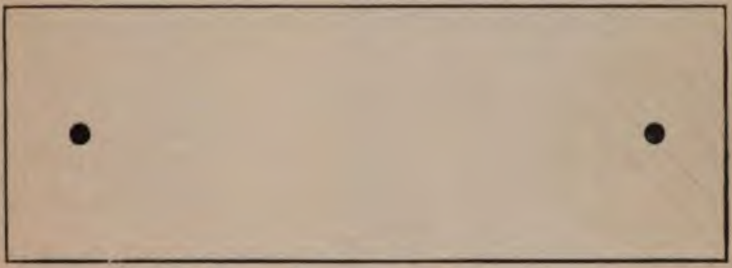

FIGURE 20.

If instead of two identical spots we use two different figures or two differently-colored spots or areas as objects for the same two fovea to focus upon, they cannot appear as a single object but *alternately* displace each other from view. This is the phenomenon known as retinal rivalry. If one looks with each eye upon a different image, as in Fig. 21, sometimes the one sometimes the other will be perceived. A piece of cardboard or paper ought to be placed in a vertical position on the middle dividing line so as to confine the vision of each eye to the figure or system of lines immediately in front of it. As Helmholtz puts it, we find that we are able "to attend voluntarily now to one and now to the other system of lines; and then that system remains visible alone for a certain time, while the other entirely vanishes. This happens, for example, if one attempts to count the lines first of one and then of the other system; but it is extremely difficult to chain the attention down to either one of the systems, for long," etc.

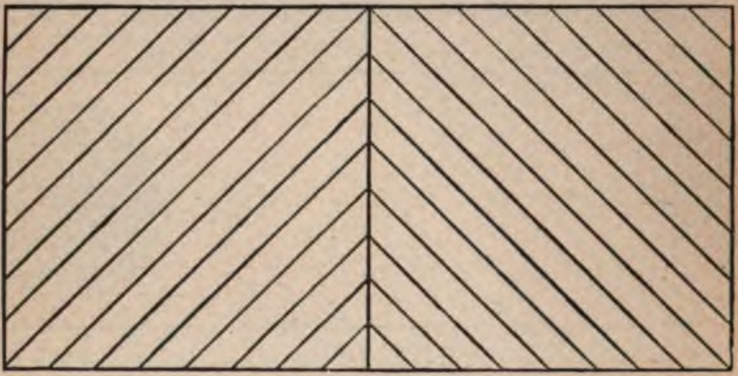

FIGURE 21.

That the rods and cones of the retina are arranged in a mosaic is indicated in Bergman's experiment. Place the system of lines in the left portion of Fig. 22 in a good light and gaze fixedly at it from a distance of about 5 feet. You will notice an apparent bending of the lines, as shown in the portion A, of the same figure. This is, of course, explicable on the basis of the mosaic arrangement. The retinal elements on which one of the white lines happens to fall are stimulated according as they are more or less touched, give rise to corresponding sensations.

If, after looking intently at any bright object with a reasonably clear outline, we close our eyes, it is found that an image of the object remains for some time and only fades out of sight gradually. This phenomenon is known by the name of "after-image." After-images in which the arrangement of light and shade found in the original object is preserved are called *positive after-images—i. e.*, the bright and dark parts correspond to those of the original object. Those after-images in which this relation is reversed are called *negative after-images*. The positive after-image has a color like that of the original object. In the negative the opposite or complementary colors are evoked.

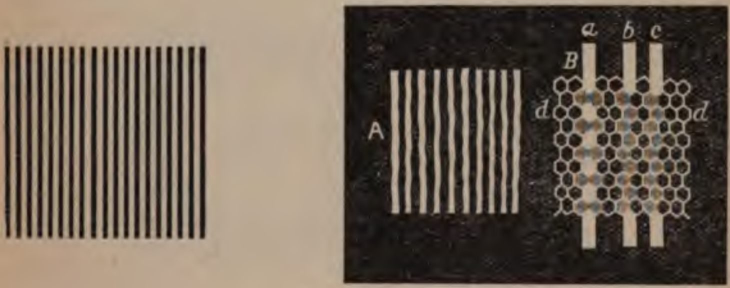

FIGURE 22.

If some morning you look steadily for a minute at the window of your room and then direct your eyes so as to look on a whited wall or screen the dark parts of the window will appear light, and *vice versa*. The arrangement of light and shade are here reversed just as in a photographic negative. If we look at a green surface for some time and then fix the eye upon a white sheet of paper or screen we find that the latter will contain an image of *red* color corresponding in size and outline to the original green surface. For example, if you look for a moment at a small green circle and then fix your eyes upon the white surface you will see within the bounds of the white surface a *red* circle as the negative after-image. Negative after-images are really a form of retinal fatigue, but the positive are in all probability due to the inertia of the retina.

Bright surfaces are always enlarged at the expense of dark surfaces by which they may happen to be surrounded; this is called the phenomenon of irradiation. With Fig. 23 in a good light, notice that the white squares seem larger than the black, though they are actually of the same size.

In the same connection it should be mentioned that color influences the apparent size of an object. Every woman knows that her hand looks smaller in a black than in a white glove. The society belle declines to wear a white slipper to the ball or german because it makes her foot appear larger and less dainty than would a red slipper. The gray shades of suiting make a man appear larger than when he wears a soft black. You have observed the same thing with reference to the colors of dwellings. A house painted a gray or light stone color will seem larger and nearer to the street (if one is looking at it from that point of view) than it would if painted any other color.

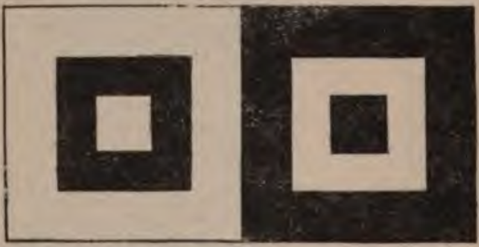

FIGURE 23.

We now come to speak of the phenomenon of color blindness. With certain persons certain defects of vision exist of such a nature that they are unable to distinguish some of the color shades. Such individuals are said to be "color blind." A little more than one hundred years ago it was discovered that there were persons who could not distinguish certain colors. The first case recorded was that of John Dalton, the celebrated English chemist. The description he made of his defect was widely read and attracted general notice. The defect itself was named "Daltonism." About four per cent. of persons, or one in every twenty-five, are color blind.

This phenomenon is quite frequently met with among railroad men, especially locomotive engineers, a number of whom are blind to the red rays. That they are "red blind" is probably due to the fact that in their long apprenticeship as firemen their eyes became over-stimulated by the red rays of the glaring furnace grates, so that those elements of the retina whose function it is to perceive red have simply been so fatigued and "worn out" that they cannot "take up the burden of life again." Holmgren's method of testing color blindness is the one ordinarily employed. Spread the variously colored worsteds on a white cloth in good daylight. Select any one distinct color—*e. g.*, a light blue—and ask the person serving as subject to select from the mass of worsteds all the other skeins that seem to him to be the same in color as the standard you have already laid to one side. If he makes errors in putting pink, gray, green, buff, lavender, lilac, magenta, etc., with the blue skein you selected, he is evidently color blind. Red blindness is most frequently met with, while violet blindness is exceedingly rare.

A person red blind sees black and white and their mixture, which makes gray, much the same as others do. He cannot distinguish correctly the color of any red object. If the object is very bright red, it looks like feeble green, and if feeble red, it appears black. The explanation of this, according to the above theory is that the waves of light from a red object on entering a red-blind eye do not produce the sensation of red, because the red perceiving nerve elements are absent, but they fall on the green and violet perceiving elements. The waves of light from green objects are nearest the length of those of red objects, and the waves from bright red objects excite the green perceiving nerve elements slightly, producing the sensation of feeble green, while feeble red is not sufficiently strong to excite them, and the sensation is black or *perhaps a brown.*

Yellow, which is a combination of red and green, appears green to the red blind, as the red part of it produces no impression except on the green-perceiving nerve elements.

Red and green objects may appear to him of the same color, only differing in intensity. An intense red and feeble green may appear to him to be of the same color. "A color-blind officer once desired to purchase a blue uniform; he chose a blue coat and waistcoat and red breeches, which he supposed matched."

Another case is that of a person who said he could not see any difference between the red ripe fruit on the trees and the leaves; a boiled lobster and a cucumber were to him of the same color.

Another wrote a letter, part with black ink and part with red, without being aware of any difference. Another says a red-brick house and the green lawn on which it is situated are of the same color.

A color-blind engraver says his defect is an advantage to him, as he sees colored objects in black and white, just as he desires to engrave them. A color blind person picked up a red-hot coal and asked what that funny green thing was. Another, an artist, painted a landscape with red trees. Another purchased a pair of green pants supposing they were brown. An architect copied a brown house in blue and green and made the sky above it rose color. A post-office clerk, who sold the stamps, found himself in trouble because he did not distinguish the red from the green stamps by their color.*

Color blindness is, however, normal at the periphery of the retina. This leads us to make mention of the fact that important changes in the quality of our sensations are dependent upon the portion of the retina on which the visual image falls. The entire retina can be divided into three belts or zones—a central one (the belt immediately surrounding the yellow spot), a middle zone and an outer or peripheral one. In the zone immediately surrounding the fovea, nearly all colors can be recognized. Outside of this is the second zone, in which blue and yellow can alone be distinguished. Farther out at the periphery, color shades cannot be distinguished at all, the various colors all appearing black, white or gray. In passing from the center to the periphery red changes at first into orange, then into violet and blue in turn, and finally, into grey as it passes out from the field of vision.

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* Many other such examples are found in Superintendent Peckham's interesting article on Color Blindness—Wisconsin Board of Health report for 1881.

Have you ever tried this interesting experiment? Require the subject to fix his attention on some designated point directly in front of him. While his eyes are thus fixed on this point, approach him from behind with a pencil or small stick, or, better, a black piece of pasteboard, at the end of which is a small bit of colored paper—*e. g.*, yellow. Observe how far forward it must be moved before he will discern its color. You will notice that some colors must be moved much farther forward than others in order that they may be recognized. Furthermore, you will observe that the object is seen, no matter what be its color, long before the color is itself recognized.

It is a disputed question as to how many colors are distinguishable. You remember Newton speaks of the "seven primary colors." Some of the colors he names, however, are not any more primary or fundamental than many he omits. At any rate, it is certain that his classification is very unsatisfactory. Why indigo should be given a place in his list while brown is shut out, is difficult to conceive. We know that the number of color tones discernible by the human eye is very large. In oil the average person can perceive 125 colors. Herschel makes the claim that the worker on the mosaics at Rome must have distinguished at least 30,000 color tones.

It has been claimed that certain of the early nations—that is, the human race at a certain primitive stage of culture, had no color sensations—they were color blind. In one of his earlier writings, Gladstone makes the claim that the ancient Greeks were color blind to blue, and bases this claim on the fact that Homer had no proper terms for blue. Also in describing the rainbow no mention was made of blue. The Bongo negroes of Central America designate *but two* colors—red and black. It is interestin to note in this connection that some insects have distinct color sensations.

If certain colors, for example green and red, are in some way united on the retina, we have a distinct sensation of a new color tone very unlike either of the two thus united. If red and green are so united we have the color called "white." Two colors which by their admixture produce white are called complementary colors. For every color there is another which, if mixed with it, will produce a colorless combination. The complementary colors for different persons are not always the same, and the two eyes of the same person may differ in this respect. The subjoined table of Helmholtz, has some general significance as bearing on this subject of complementary colors:

Color.	Complementary Color.
Red	Green-blue
Orange	Blue
Yellow	Indigo-blue
Green-yellow	Violet

The effect of one color on another when two patches of color are adjacent or are presented to the eye, one directly after the other, is called *contrast*. You all know that a bright object appears brighter with surroundings darker than itself and darker with surroundings brighter than itself.

We have both *successive* and *simultaneous* contrast. Select a piece of medium gray paper from which cut four small squares (each about one-half inch square). Then choose four differently colored sheets of paper—*e. g.*, bright red, yellow, blue and green, each piece about six inches square. Lay one of your small squares of gray on each of these colored pieces and cover them all with a piece of white tissue paper. Your gray squares that are actually of the same shade now appear to be of different colors. In each case they assume a shade or color tone complementary to that of the large color surface on which they lie. Thus the gray square that happens to lie on the blue ground will appear yellow, the one on the green surface will appear a deep pink, the one on the yellow will appear blue, while that on the red will appear green.

The retinal image in the human eye is, as you know, always inverted; the points that are at the right and upper portion of the object are at the left and lower portion of the image, and *vice versa*. Still we do not see the object inverted, corresponding to the image on the retina, but we see it "right side up" corresponding to the object itself. That the image on the retina is inverted is specifically characteristic of the eyes of vertebrates. The composite image in the compound eye of the glowworm or fly is not an inverted but an upright retinal image.

Again, how is it, having two eyes and therefore two retinal images, that we do not see objects as double, as we do when we push the side of the eyeball with our finger when gazing fixedly at an object? The customary union of the two retinal images is in the main accounted for by the crossing of the optic nerve fibers, for by this means the excitations produced in the left half of each retina are joined and together conducted to the right hemisphere of the brain, and *vice versa*.

With a single motionless eye we could have no possible perception of solid objects. The retinal images are superficial and planiform, but the mind sees things as solids. The mind, then, associates the ideas gained through movement and touch with those of simple vision. A person that is blind from birth and receives his eyesight later in life as the gift of supreme surgical skill, conceives all objects to be directly in contact—in actual touch with the outer surface of the eyeball. He only learns by degrees to project his sensations of sight accurately with reference to both distance and solidity.

By vision alone a sphere is perceived simply as a delicately shaded disk. A cube is a flat surface bounded by converging lines and abruptly shaded. Ruskin says: "The whole technical power of painting depends on our recovery of what may be called the innocence of the eye; that is to say, of a sort of childish perception of these flat stains of color merely as such, without a consciousness of what they signify as a blind man would see them if suddenly gifted with sight."

In normal circumstances sight is the leading avenue of perception or observation. The superiority of vision to the other senses is due to the fact that by means of this avenue of sense we can apprehend things at a distance as well as those that are near, as well as a great many things at the same time—for example, the variously colored leaves of an autumn tree, or the pattern of a wall paper or carpet. And again the eye calls forth our admiration on account of the extreme delicacy with which it acts. It can pass from one object to another with a swiftness which none of the other end organs of sense can imitate. It thus gathers a large amount of data in a very short time. It places these data at the service of the intellect as quick as the intellect can use them. The eye has always been regarded as the noblest of the sense-organs.

As all know, we are exceedingly dependent upon the acquired perceptions of sight. Of these acquired perceptions there are several classes. In the first place we judge of distance by size. Again, if we know the real size of an object we estimate its distance by its apparent magnitude. If we actually know the flying bird to be an eagle, and yet find that it appears exceedingly small we are sure that it is a great distance from us. If we are on the roof of a building and know that the persons walking on the streets below are full-grown men, which, however, look to us from our elevation like pygmies, we judge, and judge rightly, that we are quite a considerable distance from the ground. Likewise we judge of magnitude by the assumed distance. If we have a correct idea of the distance we perceive them full size. If, however, we are deceived as to the distance we always make serious errors with reference to the actual size of the object. A fly skipping across the window-pane may for a moment be regarded as a large bird at a great distance. If, however, the magnitude be unknown we judge of distance by means of the clearness of the color, the sharpness of the outline, and the intensity of the impression which the object makes upon us. The traveler from the Atlantic Coast States r the smoky Eastern city, who travels across The Plains judges e mountains of Colorado to be far nearer than they actually are. e hear of many laughable experiences of tourists who have at- *pted to walk* to a given mountain before breakfast, thinking it to be but a short distance, but discovering that it is actually several miles away. Such an illusion is due to the fact that the atmosphere is much more transparent than that to which the traveler is accustomed. Furthermore, intermediate objects affect our judgments of distance and therefore our judgments of size. This accounts for the fact that the sun and moon appear larger at the horizon than at the zenith. The intensity of the impression also plays an important part in these judgments of distance. If a light makes but a faint impression on us we judge it to be at a considerable distance. When the locomotive engineer, as he speeds his train through the darkness, perceives the lights of the distant station which are therefore at about the same distance from him, he knows which are the red and which are the white lights, though they evoke no color sensations. This is because the red light always gives rise to a more intense sensation than a white light at the same distance.

The blind man can have no notion of what we mean when we speak of objects appearing smaller as they move away, because he is compelled to always think of them as of their constant tactile size just as he recognizes them by their "tactile names" after he has been made to see.

LESSON XII.

SENSATION (CONTINUED).

HEARING.

THE human ear consists of three portions—*the external ear* or *concha; the middle ear* or *tympanum;* and the *internal ear* or *labyrinth.* (For a description of the structure of the ear the reader is referred to any good book on anatomy. Space will not permit a detailed description here.)*

The internal ear is really the organ of hearing and consists of a complicated and tortuous bony tube or chamber resembling somewhat the interior of a snail shell. The function of the external ear (the expansion seen on the exterior of the head, called the *concha*) is to receive, convey and modify the vibratory action of the air until the tympanum is reached. The tympanum, or "drum of the ear," consists of a parchment-like substance which is connected with a chain of bones that play upon a membranous chamber inclosing a liquid substance.

Bodies vary in the ability to emit or convey sound. This is the same as saying that their susceptibility to vibration is different. A stick of timber or bar of iron will convey to the ear in contact with it the sound made by a scratch of a pin, for hundreds of feet. Likewise the rudely constructed toy telephone of childhood days will convey a whisper for a long distance, though it consists of nothing but two pasteboard collar boxes connected by a piece of twine from 1,500 to 3,000 feet in length.

Waves that are non-periodic produce what is called a "noise;" when these same auditory waves are periodic they constitute a "tone" or "note." What are ordinarily called noises are really accompanied by musical notes. The slamming door is accompa-

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*The best published work thus far is that on "The Vertebrate Ear," by Dr. *Howard Ayers.* Published in *Journal of Morphology*, May, 1892.

nied by some music. Likewise all tones are accompanied by noises. For example, the scraping of the violin. Noises may be compounded out of musical notes. Thus, when you strike a single key on the piano you have a musical tone. Strike all the keys at the same time and you have, instead of several musical notes, a most outrageous non-musical noise.

The various efforts made by scientists to determine the lower limit of sound for the human ear, have resulted in disagreement. The difficulty, of course, lies in the fact that the absolute stillness essential to the perfect working of the experiment can never be secured. The best record of which we know up to date gives the result of researches made by Schafhäutl who fixed the lower limit of sound as that made by a cork ball weighing one milligram (.0154 grains), falling from a height of one millimeter (.03937 inch). The acuteness of hearing is frequently increased by disease. "Exalted hearing," by which is meant an unduly keen perception of sounds, is common to many disturbances of the nervous system, both functional and organic. As a rule, the intoxicated person has the experience of "exalted hearing," *i. e.*, his sense of hearing is more acute than when he is in a normal or "sober" condition. The test usually employed by railroad corporations to discover the acuteness of the sense of hearing in their employés serves very well as a laboratory test, though crude it may seem, for the purpose of determining the minimal sounds that can be heard. The experiment should take place in a large carpeted room, as free as possible from noise. Let the subject be seated with his side toward the experimenter. He should be blindfolded and have the ear opposite to the one being tested plugged with cotton. The experimenter then endeavors to find what is the greatest distance at which the subject can hear the tick of a watch which is held at the level of the ear. The distance at which the sound of the watch-tick can be heard may be found to vary from three to seven yards.

Attention has already been called to the fact that by bringing the finger in contact with a cogwheel revolving at a given rate, or a tuning fork, we may have as many as 1,000 sensations in a single of sound that are alike in quality but different in intensity, and then requested him to determine an acoustic stimulus that would give rise to a sensation that could be classified as lying directly between the first two. Experimenting in this way Merkel and others have found that the just perceivable increment of loudness required an increase of three-tenths of the original stimulus between 20 and 5,000 of his arbitrary scale.

The discriminative ability of the ear both for differences in pitch and for differences in intensity is largely influenced by repetition and by amount of time that elapses between the two stimuli producing the sensations that are to be compared. Two tones so closely related as to be just distinguishable when heard in immediate succession appear to consciousness as one and the same when the interval is over one-half of a minute.

We are quite likely to be mistaken with reference to our judgments of the *direction* from which sound comes and the location of its source. When the head is held at rest and a sound stimulus occurs, we frequently make mistakes by saying the sound came from before when it really came from behind; that it came from above when it really came from below. Sound coming from the right and left is also exceedingly difficult to distinguish when the head is kept motionless. Of course we are guided by experience. Weaker sensations of sound are localized at a point remote from us, while the stronger sensations are regarded as coming from a point quite near. Seat a person and blindfold him. Snap a telegraph sounder at different localities about two feet from his head and require him to designate the point from which the sound came. You will find that the above statements with reference to errors in judging the distinction of sound, are more than verified by such an experiment.

Continuous sounds are more difficult to localize than short, sharp, rapid sounds. In a room heated by steam, blindfold a person standing near the center, turn him round and round until he loses all notion of the points of the compass. Open the stopcock f the steam radiator and he will misjudge its location nearly *ery time.* The slight sound made by the breathing of a sleeping child in the next room may be interpreted to be the wail of a hound in the distant woods. The writer remembers when a boy of being terribly frightened by "ghosts." A noise was heard presumably directly overhead in a vacant attic. The ghost stories and pale face of the servant influenced the childish judgment. On the morrow it was discovered that the aforesaid ghost was nothing more than the noise made by the scraping of a limb of an apple-tree against the side of the house as the wind blew. The sound really came from a point at least forty feet removed from the supposed origin, and from a point almost directly opposite. Did you ever wait for a train at the noisy depot, with the engines passing back and forth? Have you not at such times at the sound of an approaching engine hurriedly snatched your traveling bag with a view to getting a good seat, rushed to the platform and found, instead of your train, one going *in the opposite direction?* If you ever have an opportunity, stand for a minute on State street in Chicago and seek to judge from which direction comes the sound of the gong of the cable car. Just a moment ago while writing the above I was thoroughly deceived by the slight hissing, whistling sound of a disorganized gas jet turned up to its full lighting power. This little annoying sound until just this instant I thought to be the whistle of a locomotive three-quarters of a mile away, instead of coming from any part of my "den."

Seasickness begins with the ear. In the internal ear or labyrinth are three little tubes which are placed at right angles to each other, just like the three sides at the corner of a book or cubical box. They are bent circular and filled with a fluid. They are more frequently known as the semicircular canals. You can see if one's head is moved at all the fluid in some one of these three tubes is set in motion. Jutting out from the inner surface of each of these canals are hairs or ciliary processes which connect with nerve cells that are in touch with the auditory nerves, and by this means connected with the auditory center on the brain-surface itself. As the peculiar nerve current caused by the motion of the head is transmitted to the brain it, at one point on its journey, runs near the "center" where the nerve controlling the stomach has its origin. When the moving and jerking of the head is too prolonged or too violent the stimulus is so great that the center for the nerves of the stomach is excited, causing the poor voyager to give up his dinner, or, to speak in more approved vernacular, he is impelled to "cast his bread upon the waters." Deaf mutes, the semicircular canals of whose ears are affected, are never seasick just as they are never dizzy, and for the same reason.

Hearing possesses the highest significance in the development of every human mind. Without the sense of hearing vocal utterances would never become language.

Sounds are also significant as expressing the emotional life of man. Even simple and articulate tones can express the deepest feeling, though no words are coupled with them. The sigh of distress, the peal of laughter, the whine of a beggar are as clearly understood and sometimes more clearly understood without any accompaniment of words. Mendelssohn's "Songs without Words" cannot fail to touch every person who hears them. Humanity is unanimous in naming one of these musical gems "Consolation." The sense of hearing enables a man to communicate with his fellow man. The brotherhood of man is directly dependent upon the sense of hearing. The voice is the interpreter of nearly all the emotions. As an intelligent blind man remarked with great emphasis, "The human voice is to me the divinest endowment of man." Certain it is that the dignity of hearing is above that of any of the other senses.

A comparatively frequent phenomena is that known as color audition or pseudo-chromesthesia. By these and similar terms it is meant to signify that large class of phenomena in which colors are called up in the mind of the person when certain letters or words are spoken or seen in print or writing. These experiences indicate a peculiar "faculty" by means of which any primary sensation can evoke, in the case of some persons, a false visual sensation of color constant in the case of the same stimulus with the same person.

A considerable number of cases have been investigated by the writer, but only one is selected on account of limited space. It is that of a young lady, much above the average in intelligence and very accomplished. She is a skillful musician, having taught in a conservatory of music for some years; very well informed as to literature, and is herself a pleasing writer. With her these pseudo-color impressions are produced in three ways: First, and chiefly, when she *sees* the graphic forms of words and letters; second when she *hears* letters, words and other sounds; and, third, by means of *association* of ideas. With this person *all* the letters are colored and as follows:

A = opaque white.
B = dark cactus green.
C = pale yellow.
D = tan color.
E = warm gray but pale.
F = very dark brown.
G = yellowish bright tan.
H = red, crimson.
I = black
J = black, sometimes shades into green.
K = red—very like H.
L = black.
M = blue.
N = gray.
O = black on white ground.
P = bright yellow.
Q = Naples yellow (buff).
R = dark green.
S = light green.
T = red; less intense than H or K.
U = gray.
V = pearl—slightly lavender.
W = black.
X = red; still less intense.
Y = yellow into green.
Z = brown sometimes shading into an iridescent purple.

The numerical digits are also colored. Thus 1 is black like i; 2 is opaque white, like a; 3 is bright green, slightly yellow; 4 is seal brown; 5, black; 6, gray; 7, yellow; 8, pink; 9, brown, lighter than 4. The colors of numbers are often and even generally more intense than those of letters.

In music written in different keys, C, D, etc., the music has a general background of color which is the same as that of the index letter indicating the key. Thus, music written in the key of D is tan color. All "sharp" keys are brighter and "flats" are less brilliant.

Words pronounced alike but spelled differently have different colors. *Words generally* take their tone of color from the initial letter. Thus with the same letters in different combinations we have different color-impressions—*e. g.*, *deer* = tan; *reed* = greenish yellow. With this person we find there is an intimate relation between form and color. In grouping several letters of one color we find that H, K, T, and X are red; B, R, S, and 6 are green; C, G, P, Q, Y and 7 are yellow; Z, F, 4 and 9 are brown; N, U, V, A and E are gray.

Furthermore, the membrane of the ear is able to give us, by means of faint and delicate pressure sensations, a pretty good picture of the outside world irrespective of our eyes. Suppose you close your eyes when quietly seated; have some one bring a large object like a book or block of wood near to your face in a perfectly noiseless manner; you at once become aware of its presence and then of its departure. Most persons, when blindfolded, can readily tell by the "feel" in the ear and face whether the object placed near to the face is thick or thin, solid or open, etc. Thus any one can distinguish between a solid board, a perforated board, a piece of wire gauze and an empty frame, respectively.

Mr. Dresslar has made some interesting investigations into this subject.* As apparatus he used a light framework of wood four feet long and one foot wide, and divided into four spaces, each one foot square. The first one of these spaces was left open, the second latticed with strips three-quarters of an inch wide, and with spaces of one-half of an inch between them; the first space was closed solidly with a panel of wood, while the fourth was filled with a wire screen. The frame was then suspended from a high ceiling by four strings fastened in pairs (so that it would swing lengthwise easily and without swerving) and made to
g low enough to be opposite the face of the subject. A silk
was fastened to the ends of the frame, and passed over
ulleys inserted in standards set about ten feet from each
the frame. The two ends of the strings were then tied to-
to furnish the operator an easy and noiseless method for
he frame so as to bring the different spaces opposite the
ce of the subject.

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The method of experimentation was as follows: The subject with closed eyes was blindfolded in such a way that little or none of the face but the eyes was covered; he was seated comfortably with his face at a distance of two or three inches from the path of the frame, and asked to judge between two spaces irregularly presented. He was required to indicate his judgment by a pre-arranged system of signs in order to prevent any reverberation of the voice which might vitiate the results. The first set of judgments were thus taken, and were for the purpose of finding the degree of power to distinguish between the three following pairs: Open—lattice; lattice—solid; solid—wire. The accompanying table shows the discriminative ability thus discovered for three different subjects:

SUBJECT.	OPEN AND LATTICE.				LATTICE AND SOLID.				SOLID AND WIRE.			
	R.	W.	R.	W.	R.	W.	R.	W.	R.	W.	R.	W.
J. A. B. . .	65	15	59	25	58	2	56	0	45	0	46	2
O. C.	72	47	74	46	33	13	28	14	21	4	14	9
F. B. D. . .	53	24	58	17	69	1	70	4	73	0	77	2

Explanation of Table.—The figures in the columns marked *R* indicate the number of correct judgments, those in columns marked *W* incorrect. For example, when J. A. B. judged between the open and lattice spaces, he made 65 right and 15 wrong judgments in 80 presentations of the open, and 59 right and 25 wrong in 84 presentations of the lattice; while judging between lattice and solid, he made 58 right and 2 wrong judgments in 60 presentations of the lattice, and 56 right and no wrong judgments when the solid was presented, and so on for all the others.

Of course in the ordinary routine of daily life the normal person makes no use of the feeling of "shut-in-ness" he experiences when a more or less solid object is held near the face. The blind, however, are very dependent upon this peculiar class of sensations. No man enjoys traveling more than the blind man. He can tell whether his train is wending its way through a hilly, uneven country or over the broad plains. The blind man is ever aware of the extent of his horizon. In an interesting book, "Blindness and the Blind," its author gives an interesting account of how the blind receive their perceptive images: "Whether within a house or in the open air, whether walking or standing still, I can tell, although quite blind, when I am opposite an object, and can perceive whether it be tall or short, slender or bulky. I can also detect whether it be a solitary object or a continuous fence; whether it be a close fence or composed of open rails; and often whether it be a wooden fence, a brick or stonewall, or a quickset hedge. I cannot usually perceive objects if much lower than my shoulder, but sometimes very low objects can be detected. This may depend on the nature of the objects, or on some abnormal state of the atmosphere. The currents of air can have nothing to do with this power, as the state of the wind does not directly affect it; the sense of hearing has nothing to do with it, as when snow lies thickly on the ground objects are more distinct, although the footfall cannot be heard. I seem to perceive objects through the skin of my face, and to have the impressions immediately transmitted to the brain.

"The only part of my body possessing this power is my face; this I have ascertained by suitable experiments. Stopping my ears does not interfere with it, but covering my face with a thick veil destroys it altogether. None of the five senses have anything to do with the existence of this power, and the circumstances above named induce me to call this unrecognized sense by the name of 'facial perception.' When passing along a street I can distinguish shops from private houses, and even point out the doors and windows, etc., and this whether the doors be shut or open. When a window consists entirely of one entire sheet of glass it is more difficult to discover than one composed of a number of all panes. From this it would appear that glass is a bad con- tor of sensation, or at any rate, of the sensation specially nected with this sense. When objects below the face are ed, the sensation seems to come in an oblique line from ct to the upper part of the face. While walking with a Forest Lane, Stratford, I said, pointing to a fence which separated the road from a field, 'Those rails are not quite so high as my shoulder.' He looked at them and said they were higher. We, however, measured and found them about three inches lower than my shoulder. At the time of making this observation I was about four feet from the rails. Certainly in this instance facial perception was more accurate than sight. When the lower part of a fence is brickwork and the upper part rails, the fact can be detected, and the line where the two meet easily perceived. Irregularities in height, and projections and indentations in walls can also be discovered."

LESSON XIII.

DEVELOPMENT OF THE SENSES.

We now propose to speak of the early development of the child's intellect. Since all knowledge begins with sensation, this statement means no more and no less than to say that in this chapter our endeavor will be to trace the processes of growth with respect to the *sense perceptions* of the infant's earliest life. The question we are really occupied with is: By what process of unfolding, in what order, from what germ beginnings, through what steps or stages, does the child mind develop and mature its powers of sense perception?

The difficulty one meets in endeavoring to answer such a question is almost insuperable, since it is impossible by memory to bring back a single vestige of the experiences of the earliest days of our infant life. As far as memory is concerned, the first days of our childhood are shrouded over with a cloud of impenetrable obscurity. Not a single one of the "first" sensations can be called up in memory. No individual can ever possess memory power so potent as to be rewarded with success in its endeavors to call up to the mind the first experience had with the eyes, ears, fingers, etc. Ask yourself the question: What was the first object I ever saw? What was the first sound I ever heard? What was the first thing I ever touched? What was my first sensation of temperature, taste, smell, motion and the like? To even propose such questions seems the height of folly. A little snatch of poetry from Dr. Holland's "Bitter Sweet" does not come amiss when we think of the immense difficulty that confronts every investigator in the realm of Child Psychology:

Who can tell what a baby thinks?
Who can follow the gossamer links?

By which the mannikin feels his way
Out from the shore of the great unknown,
Blind and wailing and alone,
Into the light of day?

* * * * *

What does he think of his mother's eyes?
What does he think of his mother's hair?
What of the cradle-roof, that flies
Forward and backward through the air?

* * * * *

What does he think when her quick embrace
Presses his hand and buries his face
Deep where the heart throbs sink and swell
With a tenderness she can never tell,
Though she murmur the words
Of all the birds—
Words she has learned to murmur well?

But we can tell what our infant life must have been by performing certain experiments and making certain observations upon children from the very first hour of their existence. How it must have seemed to *us* as children we cannot possibly tell. Upon the investigations of Child Psychology the introspective methods shed no direct light. Observation and experiment are the only methods by which we learn the content of a child's mind at any stage of its development. Such tests must be so adaptable that they can be applied to any child. Although each child has the same sense organs, and the same fundamental modes of sensibility, we find that striking differences of sense capacity are met with in different individuals. No two children are *exactly* alike in their sense development. It is impossible for them to be so. Each child that enters a school at six years of age is different from every other child in that school. His eye, ear, hand, and all of his sense organs have been trained differently. The child as he presents himself at the schoolroom door is not a rounded-out normally developed child. He may have had his eye developed at the expense of his ear, or his ear developed at the expense of his tactile sense, etc. Now the function of the teacher is to develop the mind of the child normally. This means that the various avenues of sensation must be trained equally well. By the training or cultivation of the senses is meant the even, harmonious, steady exercising of the child's sense organs so that these organs will become efficient and valued instruments, capable of being used in observation and discovery.

We all know, if we have observed children at all, that they develop the power of perception by many experiments and many mistakes. By the same principle that the colt is broken into the harness or the dog is trained to know his place and function, does nature educate her dearest child—man. If he obeys her laws his life is one of harmony, freedom, delightful satisfaction and joy. If he runs counter to the rough edges of stern law it wounds and pains.

Dr. Moebius, professor of zoölogy at the University of Kiel, relates an interesting experiment performed by Mr. Antsberg of Stralsund.

"A pike, who swallowed all small fishes which were put into the aquarium, was separated from them by a pane of glass, so that, whenever he tried to pounce on them, he struck his gills against the glass, and sometimes, so violently, that he remained lying on his back as if dead. He recovered, however, and repeated his onslaughts till they became rarer and rarer, and at last, after three months, ceased altogether. After having been in solitary confinement for six months, the pane of glass was removed from the aquarium so that the pike could again roam about freely among the other fishes. He at once swam toward them, but he never touched any one of them but always halted at a respectful distance of about an inch, and was satisfied to share with the rest the meat that was thrown into the aquarium. He had therefore been trained so as not to attack the other fishes which he knew as inhabitants of the same tank. As soon, however, as a strange fish was thrown into the aquarium, the pike in nowise respected him but swallowed him at once." In something of the same way as the pike learned his lesson by striking his gills against the glass, the child learns that the fire burns, the knife cuts, the needle pricks, and the like.

Leaving these more general observations we come to the direct and specific question—What is the primary condition in which the mind of the infant exists before the first beginnings of conscious activity? We can best answer by saying that it is very closely allied to the state of unbroken sleep undisturbed by dreams. Or it may be likened to a "dead faint" in which little shimmerings of sensation are experienced in such an indefinite and vague way that they never enter into clear perception. The soul or mind of the infant never has sensations in the fullest sense until there is a keen, clear-cut, positive experience of pain or pleasure.

The sensations that are first experienced by the child are the muscular and organic sensations mentioned in a previous chapter. While it might be thought that hearing would be one of the earliest senses to develop, such is not the case. Usually several days elapse before the child can be said to actually hear. Professor Ladd puts the case clearly when he says: "All newly born children are deaf; the temporary deafness is caused by lack of air in the tympanum previous to respiration. Great individual differences exist as respects the age at which children give unmistakable tokens of having sensations of sound. It was not until the first half of the fourth day that one investigator was satisfied his child could hear." There are, however, some exceptions to this. The writer, in making some experiments on his own little girl, found that she manifested unmistakable and indubitable signs of hearing, *within two hours after birth.* Though hearing is feebly developed at first it remains the longest of any of the senses. In falling asleep, hearing is probably the last sense we lose. Likewise as death creeps over us we hear to the very last—even after the tactile sense is completely benumbed by death's chill hand. As a rule, most persons are more easily awakened by appeal to hearing than if the stimulus were that of any of the other senses. In states of stupefaction, sleep, drunkenness and the like, hearing seems to be the one chief strand that connects the mind with the outside world.

The sense of *taste* is developed still later than hearing. At first the little babe will swallow bitter medicine as readily as milk. Nearly four weeks must elapse before it can possibly distinguish the one from the other. The sense of smell comes even later. Some recent investigators claim that smell is active from the first.

Almost all agree that after the general muscular sensations, together with the organic sensations, those of the skin come next in order. Perhaps the first real sensation of pain the infant has is when the air rushes into its little lungs for the first time and by reflex action it is really compelled to cry and thus announces its début.

It is hard to say which is developed first, the hand or the eye. The race between the two is "neck and neck." We believe the evidence of recent investigation is in favor of the eye. The infant sees an object, then reaches for it. Certain it is that the child is "right-eyed" before it is "right-handed." Touch develops *more* rapidly than vision and its early discriminations are more delicate. From the very conditions of his pre-natal existence we might correctly infer that the sense of contact both with reference to temperature and pressure are well developed in the infant at birth. It is by means of touch that the child learns to distinguish his "me" from the "not-me." By touch he first learns that a portion of the world—his body—is himself and that another portion of the world of objects is "not-body." By what steps or stages in the progressive unfolding of touch does the child acquire the ability to distinguish between his "me" and the "not-me"—between himself and the world?

The first step taken, and a most significant and important one it is, is that by which the mind of the child comes to know familiarly that his own body is bounded by a limiting surface. Already certain muscular and tactile sensations have been clearly perceived. The material objects of the outside world which affect the child's sensorium come in contact with his bodily surface. ese sensations of contact are crudely and vaguely localized in skin. By coming in touch with these outside objects the *learns to know* that his body has a limit. Of this limit he is being made constantly aware. His little sense world is for the time being bounded by his skin.

A second step takes place when he observes that there is a difference between touching a part of his own body and some other object. When his little baby finger rests on the table or on the window-pane, or on the little piece of Hamburg edging with which his "swaddling clothes" are trimmed, he observes that the experience is different from that which he has when with his finger he picks his toes or touches his dimpled knee. In the latter case the surface that is touched also gives the sensation of being touched; in the case of the other objects there is no such sensation. He at once distinguishes between those objects which give a sensation of being touched and those which do not. This is the distinguishing mark between objects that are "body" and those that are "not-body."

Vision evidently begins at that very early period when the child notices and is attracted by the bright and steady light. The infant's eye is fixed on such an object and follows it for a few degrees from side to side in space. At first the child can only move his eyes laterally—*i. e.*, from right to left, or from left to right. If the object is moved up and down his eye cannot follow it at first, as the muscles which control the vertical motions of the eye are slow in receiving their training.

Statistics seem to show that very few children manifest a preference for a particular color before they are fifty days old. (See Preyer.) My own experiments have not been very extensive so far as the number of subjects is concerned, but they have been very thorough on the one little creature that has kindly lent herself for the purposes of science—my own little daughter. When she was but ten days old I began to experiment upon her with reference to her choice of colors. The experiment was very simple. Four diminutive incandescent lights of about one-half candle power each were used. The globes of these lamps were gaily colored, being a bright red, electric blue, bright green and brilliant yellow respectively. All four of these little lamps were placed directly in front of her, and then each one of them was removed in turn. The order in which they were removed from her field of vision was varied in each of these experiments. This was done three times each day, for over two weeks with no preference manifested for any one of these four colors. All pleased her child eye equally. On the 27th day, however, a distinct choice of color was manifested. The four lights were placed before her as usual. She looked at them all intently. After one minute elapsed the blue one was removed—her eye followed it a short distance and then became fixed on the three remaining ones. The blue lamp was returned to its place and the red one removed; she followed this one also for but a short distance and then allowed her eyes to again become fastened on the accustomed place. The red lamp was returned to its socket, and the yellow one removed. Her eye followed this closely, and when it passed out from her field of vision she made it very evident that she was displeased, as she knitted her brows, stiffened her back, threw back her head as if angry, looked vacantly into space, and *would not return her eyes to the place where the other lights remained burning as brightly as ever.* She evidently wanted the yellow light and the yellow light only. It was again brought within her field of vision. As quick as her eye caught the brilliant glare a marked change came over her face and she showed unmistakable signs of pleasure. The experiment was repeated twenty-three times in five days, and each time yellow was the decided preference. Kindergarten teachers agree quite generally in saying that the majority of children coming under their observation prefer yellow to any other color. The untutored savage also has a decided preference for that color—especially the African tribes. There are certainly better reasons for painting a child's toys yellow than there are for coloring them red, at least so far as the pleasure of the child is concerned.

Children do not at first see objects as we do—one object nearer than an other. At first they have no perception of distance and solidity. This is directly in line with the experiences of blind persons on first obtaining the use of their eyes. All objects appear to *them at first as* touching their eyes. Like the infant they cannot, with their eyes, distinguish between a flat drawing and a solid body.

The extension which is seen by persons who have recovered from blindness is extension of two dimensions. A solid cube or a solid sphere is taken by them to be simply a plane or a disc. A solid cube and a flat projection of the same are both taken to be flat and in every respect alike. The testimony is unanimous that objects seem very near to the eye. Some of these blind patients who, by a surgical triumph, have been made to see, in attempting to reach objects that are extended to them, grasp *behind* them when held near to them, and when more remote can only touch them after repeated trials. Some are afraid to move lest they should in some way strike their body against objects which are really quite remote; after using their eyes for some time they acquire the ability to discriminate among objects as near and far. *It is by the use of touch and sight together that the perceptions of distance and solidity arise.*

That the eye and hand coöperate in infancy is a fact borne out by all observation and experiment. Observe the maneuvers of the young child during its first days, and you will be convinced that the eye and the hand soon learn to work together. As the eye of the infant at first rests fixedly in its socket, so his hands and arms at first hang uselessly from his shoulders or dangle helplessly at his side. There are no *purposeful* movements executed by the hands or arms just as there are no objects sought out or chosen by the eye upon which to fix its "point of regard." At first the child cannot grasp or hold an object. Notice him as he tries so hard to carry an object to his mouth—how clumsily the movements are made and how unsuccessful are his first attempts. He *must learn* to use his hands just as he must learn to direct the movement of his eyes. All these uses of the hand as of the eye are learned by conscious attention. The earliest movements are made aimlessly; after many unsuccessful experiments and trials, at first more failures than successes—he finally attains the stage of hand development at which he can be reasonably sure that *the movement* he desires so much to make can be cessfully carried out. When he is finally successful in his attempt, how his every look and expression manifest the gratification he so certainly feels.

It is interesting in this connection to note that the earliest objects which attract the eyes of the infant are his hands and fingers. The hands are his first playthings. That they should be the first to receive his visual notice is but natural. They are always flitting to and fro, ever before his eyes and constantly passing back and forth in his narrow field of vision. At first, as you know, the infant is very short-sighted and can observe only the nearest objects. It seems that everything conspires to bring his hand under the direct notice of his eye for at least the first one hundred days of his life.

The growth and development of the mind is marked by three characteristics: (1) There is a gradual but rapid progression from vague unlocalized impressions to distinct definite knowledge. (2) Operations become more perfect and are performed with more facility each time they are performed. There is a general truth underlying all development, either mental or physical, that our powers are improved and strengthened by exercise. (3) There is a progress from the simple to the more complex processes of mental activity. The law of all mental growth is that *progress is always from the simple to the complex, from the concrete to the abstract.*

Not the least valuable of the conclusions of modern experimental and observational psychology is that there is a uniform order in which the faculties of the mind unfold or develop. At least four stages are observable. (1) The *sensation stage.* Before we can know anything about ourselves or the outside world we must have some one of our sense organs acted upon. Sense must supply the raw material which the intellect afterwards assimilates and uses. (2) The *perception stage.* After a number of sensations have been experienced they are grouped and classified according as they proceed from the same point in space and arise contemporaneously in time. The child gets the *sensations of yellow*, roundness, etc., and then comes to see that they proceed from the same point in space, and decides that they are the properties or qualities of one single object—the orange—which he now apprehends. (3) *The stage of re-presentation.* Under this general term are to be included memory, imagination and fancy. (4) *The stage of reflection and reasoning.* There is no break in this process of development. It is the same mind that acts in all these stages and finds expression in them. The distinction just made between the various stages of development must not be interpreted to mean that they are sharply defined epochs of growth. We simply mean to say that sensation must precede perception; perception must precede memory and imagination; and these in turn are developed before the mind's power to reason and reflect.

Furthermore, every form of mental activity, and therefore mental growth, includes an act of attention more or less intense. Intellectual growth, as we have seen, is directly attendant upon intellectual activity. It is also directly related to the development of will power, for without the development of will there can be no prolonged concentrated effort of attention. Thus it is seen that the different phases of mental development are in a way interdependent. All mental development takes place by the coöperation of two sets of agencies. The first may be denominated subjective factors, the second objective influences. By the subjective factors are meant the fundamental characteristics with which each individual mind is endowed at birth; *e. g.*, native quickness, keenness, and the like. Also under these subjective factors must be included the influence of heredity. Just as the child is born with its father's eyes, and mother's nose or lips, so certain intellectual features perdure in the shape of inherited mental tendencies.

Under the objective influences must be included all those potencies which can be grouped under the general name of environment. The *natural* environment would include the physical conditions by which the child is surrounded. *Social* environment is the term by which we designate the group of individuals with which one comes in intimate contact. Differences in one's roundings, both physical and social, have a great deal to do with the differences in capacity and disposition which we meet in different persons. It is a fundamental fact that no two individuals ever come under exactly the same influences. Even twins, born into the same family at the same time, differ in their environment from the very first. Added to this is the other fact, that owing to differences in their original capacities, the two will react quite differently to the same impressions. As life progresses, each new day presents new external influences which serve to difference the two more and more. The school into which they enter, the different friendships, various commercial interests, and the like, all help to widen the gap between the two as far as their intellectual development is concerned. This is because the mind, just like the body, develops upon the food that is supplied and which it assimilates. Thus it is that no individual is independent of his surroundings. While we cannot claim that circumstances make the man, we are warranted in asserting that one's surroundings go a long way in determining the *kind* of person he is to become. The function of the teacher is to supply just that environment which will evoke the activities most essential to a high standard of mental, moral and physical development. If the child be deficient with respect to his visual powers, the teacher is called upon to stimulate these same powers. If the pupil exercise no imagination this faculty must also be aroused into activity by the teacher. After the teacher has a definite knowledge as to the powers and capacities of the pupil, it is his chief business and we might say, his only function, to surround his pupil with the environment that will best conduce to ideal rounded-out development. The true educator must ever keep before his mind's eye the ideal of a complete, strong and well developed individual. As the first requisite in teaching is to know the child's mind, so the ultimate end of education is to prepare him for citizenship—to prepare him physically, intellectually and morally.

As the mind unfolds, one of the chief characteristics of its *elopment is* the improvement and growth of the individual's sense capacity. Of course, the child has the same kind of eye, ear, etc., as is found in the full grown man, but his sensations are more vague, hazy, and less defined than those experienced in adult life. The growth of sense capacity involves two things: First, increased discriminative ability; second, the recognition of sensations by their color, tones or local signs.

At first the child exercises no discriminative ability. His sensations are all confused with one another. That his discriminative ability can be developed to a high degree is shown by the exceptional delicacy possessed by those who have occasion to employ a certain sense much more than other people. You have observed, no doubt, the fine tactile sensibility of the blind, the delicate muscular discrimination of a wood carver, the acute auditory sensitiveness of the skilled musician, and the keen gustatory perceptions of the professional tea taster in the customs service. The case of Julia Brace is pertinent in this connection. As a pupil of the school for the blind it was her function to sort the clothing of the several hundred inmates as it came from the laundry each week. The stupendous task of properly assorting these garments, numbering into hundreds, was done entirely upon the basis of a discrimination made by the sense of smell alone.

As stated above, to train the senses means simply to exercise them so as to make them efficient and accurate in observation and discovery. The first step in this training consists in the development of the discriminative ability of the various senses. By this means, quickness and accuracy of sensation is assured. It must also be remembered that distinct and sharply defined impressions are the first conditions of clear imagination, good memory, and precise thinking. If a child always confuses his sense-impressions—his sensations of color, taste, touch, form, etc.—his mind will always act in a confused manner whether it be in the function of memory, imagination or reasoning. How magnificently nature has provided for the little child in urging him to use his eyes, his ears, his hands and other observing powers rather than take knowledge second handed from mother, nurse or teacher.

In this sense knowledge, the child comes face to face with the object. It makes an impression upon him. By this direct face to face contact, the child learns more than can ever be "crammed" into him, by the intervention of another mind. We are frequently made decidedly weary by the phrase *"to impart instruction."* Some use it in claiming that the teacher's function is *"to impart instruction,"* as if knowledge could be done up in ready made packages and foisted upon the pupils! And yet there are still some persons abroad in the land who, posing as teachers, are actually endeavoring to *impart* knowledge. What ruination such pseudo-teachers have wrought! How many child minds have been crippled and maimed because of such folly! The function of the teacher is simply to lead the child in his observations and experiments. Teacher=Leader. The true teacher simply supplies the children with suitable objects for the exercise of their sense organs. Can you teach the child how to reason? No more than you can teach the child *how* to see. No more than you can teach the bird *how* to fly. You must simply *let* it fly. Let the child learn to see as you would let the bird learn to fly. Train the senses of the child and the rest of his mental development will take care of itself. The child that *"senses"* well will always reason accurately and remember correctly. A little boy was given four wooden balls in the kindergarten. When asked how many he had, he answered "four." But how do you know you have four? "Why I see two and I see two more and *I thinked* four." *The successful teacher is the sense teacher*—I almost said is the *sensible* teacher. Not that this work must needs be disorganized and unsystematic. The kindergarten occupations, such as paper-folding, modeling in clay, stick laying, the "sense" plays, and little science lessons are, if anything, systematic and orderly. The ability to educate the senses of the children whom he is endeavoring to lead, is in fact the true measure of the teacher's power and value as a real instructor. "Educate"—What does the word mean? Look at its etymology—*"educo"*—ead from or out of. So the true teacher leads the child upward nward in its path of development by training the senses—the windows of his infant mind—to give a true picture of the outside world in which he lives and moves and has his being. You know a good building requires not only good foundations but good materials. Suppose you had a foundation of the best Westerly granite and erected thereon a superstructure of thin, warped cottonwood boards—would you have a good building? Now, our knowledge of the outside world is gained through the senses. This is the material from which our world is constructed. If the sense experiences are vague and indefinite, the knowledge based thereon will be vague and hazy.

LESSON XIV.

DEVELOPMENT OF THE SENSES.—*Continued.*

A SHORT time ago I visited what to me is very nearly an ideal Kindergarten. I merely give you one of its chapters—a very small one—culled from the morning exercises. It is simply one of those little stories with which Kindergarten lore abounds. The children had just come from their homes with expectant faces wreathed in gladsome smiles. Of course, the story loses much by being taken out of its local setting, and is reproduced here in merest outline. The eager, delighted expressions of the children as the story progressed cannot be reproduced. The whole group—twenty in all—are seated in a circle, every eye on the teacher who sits as one of the number.

Teacher. "Now, children, how many of you have at home things you are very careful of and very fond of? What is yours, Stuart?"

The children give in turn various answers, telling of their favorite playthings and keepsakes. When each has been questioned, the teacher continues:

Teacher. "Where do you keep these favorite things, these treasures of yours, keepsakes, as they are called, so that they will not be harmed?"

Most of the children say in boxes of some sort, kept safe either by covers or by lock and key; some say theirs have no covers of any kind.

Teacher. "These little boxes of yours are your treasure boxes. When I was a little girl I had a treasure box which my father made me."

Then follows a lively description in detail of this treasure box of hers, special stress being laid upon the neat, careful way in which all the contents were laid in, each thing having a little compartment or corner of its own.

"Now, I am going to show you some treasure boxes different from any of yours or mine, some of Mother Nature's treasure boxes."

She then shows them two wild cucumber pods, one of which was closed, the other riper and "unlocked"—open at one end. She calls their attention to the prickly green cover of the box, and shows how tightly and beautifully "locked" it is. Then passing them around that each child might see and handle the pods for themselves, she tells them to notice the soft white lining of the "unlocked" box, and to observe carefully the four brown seeds—the "treasures"—so neatly and orderly arranged by Mother Nature, in their little cells. Then the children are asked to guess other of Mother Nature's treasure boxes. One child has a peach in her lunch basket, and another an apple. These are both examined with a view to discover the hidden treasures—the seeds they contained. Then the teacher continues: "Now, if you should ask the tree or the plant what it loves and cares for better than anything else, it would say—if it could talk to you—its little treasure box, because all through the summer, it has been taking in the sunshine, and drinking in the water only for the sake of this little seed—its baby—to make it strong and healthy, so that it could grow on after the mother plant had died. Now, I want each one of you to bring me to-morrow one of Mother Nature's treasure boxes."

So the talk closed for that morning, but was taken up and carried on successive mornings after that, the teacher calling attention to the different kinds of boxes in which the seeds were kept, the variety and the form of the seeds themselves, the part played by the wind in scattering them, as, for example, the milkweed, the dandelion and the clematis, the bird's share in this work, etc. Ever since this story was first told them, and it is now many weeks ago, the children have continued to bring to the teacher "treasure boxes" of all sorts and kinds, not even forgetting them when they were told later the stories about the leaves and began their collection of those. With the specimens brought in, the teacher has made a chart, and the feathery seeds of thistle, clematis, milkweed and the like make a very ornamental border for the walls of their schoolroom.

Now is this not a better method of procedure for both the child's present pleasure and future mental growth, and does it not make him a more valuable man or woman, a better citizen, than the exercise the writer has seen time and again in one of the primary departments of our common schools, viz., where the task prescribed for the child was that the word "cat" should be written neatly on the slate forty times? At best, with the latter method, the mind will have absolutely no power of expanding from within; it can be no more than a mere passive recipient, able only to discharge the undigested, unassimilated mass of facts which has once been stuffed into it, paralyzing its very spontaneity in its endeavors to make new discoveries and gain new facts; in other words, no real knowledge is gained. *That education is best which seeks, not to impart knowledge, but to develop mental force.*

I am reminded in this connection of an interesting little allusion made by Thomas Wentworth Higginson in his delightful little essay on "Processes." It is an account of a schoolboy who was found in great distress over his lessons. When asked what the peculiar difficulty was, he stated this arduous problem:

"If John has two red apples, and Charlie has two, how many red apples have they both together?"

"Is that hard?" was asked.

"Very hard," the boy said, sadly.

"But surely, my boy, you already know that two and two make four; there can be no trouble about that?"

"Of course not," was the pathetic response. "Of course I know *that* well enough. But the process! It's the process that wears me out."

And do not the facts which can be observed as we visit the majority of the public schools lend force to this piece of infantine *sarcasm?* Hosts of things that come so naturally to the child's mind that they might really be taken for granted, are virtually taken from him and then offered to him again in such a cut and dried formal shape, smothered under technical definitions and "processes," that he is almost made unconscious that he ever knew them. Not only is this true of arithmetic, though I believe that this is the worst taught of any subject of the common school curriculum. Is it not true that many children who have grown up under educated influences write better English—certainly more idiomatic and often more correct—before studying English grammar than afterwards? They write as they speak, by ear, and the complex rules confuse more than they help.

Of all modern innovations that have grown up, the most important is the systematic culture of the powers of observation. As Herbert Spencer so tersely puts it: "After long ages of blindness men are at last seeing that the spontaneous activity of the observing faculties in children has a meaning and a use." To this awakening is attributed the well-conceived but ill-conducted system of object lessons. It can be said without fear of successful contradiction that if the education of the senses be neglected, all subsequent education will partake of a vagueness, haziness, drowsiness or inefficiency which will never admit of cure. The systematic development of the senses makes a place for—yes, makes absolutely essential—the object lesson. By this is meant the simple presentation to the pupil's senses of some natural object, *e.g.*, a piece of coal, an ear of corn, a hickory nut, some animal or plant, etc. In carrying out the object lesson appeal should be made to more than one sense. You are not "cultivating the observing powers" when you appeal to the eye alone. You must appeal to as many of the senses as possible, for each sense gives to the mind a different picture of the outside world. For example, the cavity left by an extracted tooth feels larger when the tongue touches it than when seen with the eye. Not long ago the writer observed some children cracking hickory nuts on the curbstone. He happened to have in his pocket some hickory nuts which were quite a good deal larger than those possessed by the children. Each child was told to close his eyes and one of the large nuts was placed in his hand. Not one of the five children could tell that it was a nut by the sense of touch alone. All had to depend upon vision, though they had all been observing hickory nuts with their touch sense. These children were deficient in their powers of tactile observation. To induce in the child a well rounded-out development, it is necessary to train all the senses; the ear should not be trained at the expense of the eye, or the eye at the expense of the hand, etc., else the child becomes one-sided in his development. The value of the object lesson depends for its efficiency as a mind developer upon theextent to which all the observing powers of the class are put to use and called into exercise. Above all things the teacher should never *tell* the pupils about the object, but should ever stimulate them to observe—see, touch, taste, hear, smell, etc., for themselves. A daily walk with a good observer will do more to develop the faculties than the most elaborate of school exercises where learning is by rule. Exhaustive, painstaking, thorough observation is an element in all true professional success, be the person a physician, engineer, teacher or preacher; be he lawyer, merchant or railroad conductor.

A wholesome change that has attended the introduction of observational studies in our schools is the growing desire to make the acquisition of knowledge a pleasant rather than a painful exercise. The effort to make all education interesting is indeed a child of the present. As long as the acquisition of knowledge is made to be habitually distasteful, as long as it is a "grind"—to use the vernacular of the college campus—so long will there be a prevailing tendency to discontinue it when free from the coercive restraint of parents and teachers.

No man has investigated the subject of educational method with such keen insight, with such excellent tact, and with such a far-seeing, judicial mind as has Mr. Herbert Spencer. His book on "Education" testifies to his right to be called the father of dern educational reform. We cannot forbear making a rather gthy quotation from him at this point. It should be ineffaceereotyped on the brain of every parent and teacher:

"See the way in which, by this method, the intelligent mother conducts her lessons step by step; she familiarizes her little boy with the names of the simpler attributes, hardness, softness, color, taste, size, etc., in doing which she finds him eagerly help by bringing this to show her that it is red, and the other to make her feel that it is hard, as fast as she gives him words for these properties. Each additional property as she draws his attention to it in some fresh thing which he brings to her, she takes care to mention in connection with those he already knows, so that by the natural tendency to imitate he may get into the habit of repeating them one after the other. Gradually as there occur cases in which he omits to name one or more of the properties he has become acquainted with, she introduces the practice of asking him whether there is not something more that he can tell her about the thing he has got. Probably he does not understand. After letting him puzzle awhile she tells him, perhaps laughing at him a little for his failure. A few recurrences of this and he perceives what is to be done. When next she says she knows something more about the object than he has told her, his pride is roused; he looks at it intently; he thinks over all that he has heard; and the problem being easy presently finds it out. He is full of glee at his success, and she sympathizes with him. In common with every child he delights in the discovery of his powers. He wishes for more victories, and goes in quest of more things about which to tell her. As his faculties unfold, she adds quality after quality to his list, progressing from hardness and softness to roughness and smoothness, from color to polish, from simple bodies to composite ones—thus constantly complicating the problem as he gains competence; constantly taxing his attention and memory to a greater extent; constantly maintaining his interest by supplying him with new impressions such as his mind can assimilate, and constantly gratifying him by conquests over such small difficulties as he can master. In doing this she is manifestly but following out that spontaneous process that was going on during a still earlier period, simply aiding self-evolution; *and in aiding it* in the mode suggested by the boy's instinctive behavior to her. Manifestly, too, the course she is pursuing is the one best calculated to establish a habit of exhaustive observation, which is the professed aim of these lessons. To *tell* a child this and *show* it the other is not to teach it how to observe, but to make it a mere recipient of another's observations; a proceeding which weakens rather than strengthens its powers of self-instruction, which deprives it of the pleasures resulting from successful activity, which presents this all-attractive knowledge under the aspect of formal tuition, and which thus generates that indifference and even disgust with which these object lessons are not infrequently regarded."

The object lesson, to serve its true function, should be carried on in quite a different manner from that customarily made use of. *The real value of the object lesson depends entirely on the extent to which the observing powers of the pupils have been employed.* The teacher must never *tell* what the object is or of what it consists, but simply stimulate the child to observe for himself. Now in the first place the attention of the child should be directed to the *object itself* with its manifold qualities, and *not* to the general truth which the object lesson is intended to illustrate. Remember always that the true order of mental procedure is ever from the concrete to the abstract. The mind must be introduced to principles only through numerous examples. Education can only proceed naturally, therefore most successfully, when this law is followed. As teachers, then, in using the object lesson, seek first of all an interesting object with many qualities which are reasonably apparent rather than deeply hidden. Then when this is done, seek to interest the child in the object and the object only. Do this by having its qualities named one at a time. Also it is important to use an object in its natural setting so far as possible. Don't use a picture of a cat when you can get a live cat,any more than you would attempt to teach the application of the table of weights and measures in your arithmetic class without using an actual pair of scales such as the grocer or butcher employs. The true teacher will teach by *e to the* concrete and the concrete alone as far as possible. In "Dry Measure" he will use the actual measures which are employed in daily business transactions. In teaching "Liquid Measure" he will "beg, borrow or steal" the concrete measuring tins such as his milkman uses, and so on. In every possible manner he will make use of the object lesson in teaching. Who ever heard of a *successful* teacher of the interesting subject of physics who depended on the text-book alone. It has been attempted by many who aspire to be teachers, but a kind Providence and American practical common sense is rapidly decimating the number of this ilk. I can remember when a boy of such a would-be teacher. Our class work in physics consisted chiefly in questions and answers on the text—a tedious, dry book called by the very comprehensive and indefinite name of "Natural Philosophy." The usual order of questions was something as follows:

Teacher. Where does the lesson begin, Nellie?

Ans. On page 97, near the middle.

Teacher. Where does it end, Willie?

Ans. I don't remember the page.

Teacher. You stupid boy, not to remember the page on which the lesson ends. You may stay in at recess. Edna, you tell where the lesson ends.

Ans. At the fourth line from the bottom on page 105.

Teacher. The entire class will now repeat in concert the page on which the lesson ends. Loud, now, so Willie can hear.

This is now done and one-third of the time is already gone. Then follows a cut and dried recitation on the interesting subject of electricity—on such themes as the induction coil, magnet, electric motor, production of heat by electricity, electric light, *without a single illustration or piece of apparatus*, when the teacher might have constructed a crude electric battery and with glass or sealing wax, a silk handkerchief, or a piece of flannel, or at least with a cheap rubber comb and a black cat, shown us some of the manifestations and phenomena of this force so fascinatingly interesting to every child. But, no! Every word in the class was *utterly unmeaning* because divorced from everything practi-

cal. Furthermore, at the same time that the writer was slowly grinding his way in this treadmill class so distasteful to him, he was engaged at home in studying a book handed to him by a real benefactor—the title of the book being "Boys' Own Book of Home Experiments." Portions of the book were read eagerly every night and interesting but simple experiments performed in the order indicated. Oh, how intensely interesting those winter nights were! With what avidity were its treasure pages read and devoured! How it took preference over and above all toboggan parties and sleigh rides, while even my new "Barney and Berry" club-skates lost their charm. But do you know that all this time I was doing this supplementary reading and performing these experiments on Light, Heat, Sound and Electricity, the thought never once occurred to me that the subject which occupied me at home so assiduously and industriously was at all related to the course on "Natural Philosophy," which was being given in school. It never, for a single instant, seemed that they belonged to the same régime. And still further, one day the writer, proud and delighted with his success in constructing an electrophorus which worked perfectly, took it to school to show his mates, only to have his so-called teacher not merely ridicule it himself, but take it to his desk and make it the object of ridicule on the part of the other pupils, by holding it up before the whole school and sneering at it with words of keen-edged sarcasm. Of course, it was crudely constructed—being made of two tin pans, surreptitiously secured, together with sealing wax, from the pantry, and insulated with a cheap broken glass pestle kindly
pplied by a good-hearted druggist; but it *did the work desired*
d it well, illustrating some of the most fundamental phe-
of electricity. Can you wonder that the writer, from
had no respect, much less love for that teacher? But
"Oh, well, that was fifteen or twenty years ago!"
but this particular teacher is not dead yet, and is
g instruction" in the same old way. If he were
this class, there would be much cause for congrat-
d to say this family of pseudo-teachers is a large

one and holds to life with exceeding tenacity. Not two weeks ago in a school, which its patrons, like true patriotic citizens, call the "best in the state," the following occurrence took place under the writer's own observation.

The class was reciting from some little, inferior work on "Natural History." The lesson was about the grasshopper. One boy discovered on a live specimen what he thought were the organs of hearing. The book also made the claim that grasshoppers *hear*. But an enterprising little fellow had read the excellent article in the Encyclopædia Britannica and found it stated that grasshoppers *do not hear*. At the same time he wrote letters to one or two professional entomologists, who concurred in the latter opinion. Thus fortified he approached his teacher in a respectful manner and told her of his discovery. Instead of congratulating him on his "find" and commending him for earnest endeavor, this particular teacher severely reprimanded him for disagreeing with the book used by the class.

How refreshing it is to turn from such instances to those schools where the pupils are led in their observations by a skillful, practical teacher to see the essence and meaning of things. Less than a year ago I visited just such a school. It was in a town of 3,000 inhabitants made up principally of horny handed toilers and their families. The teacher of the high school was a self-made man but had the *gift* to teach and teach clearly. His class in physics was studying electricity, and the boys would have me, though a stranger, stay after school to see an electric motor which they had themselves constructed with the sympathetic interest of their teacher. In the class no text-book was used, though ten or a dozen, by different authors, were on the table of their rudely constructed laboratory. By enlisting the sympathy and enthusiastic interest of his pupils, the teacher had awakened the community so that it was an easy matter to secure for the work in physics alone about $300 worth of apparatus, besides the considerable number of home made instruments constructed by the teacher and his pupils. Is it not better that the average schoolboy know *one* single concrete fact in physics, e. g., how to wire an electric bell, than for him to be able to recite Steele, Gage, Norton, or Quackenbos by the yard and hour in an unmeaning manner?

But this may be a digression. It may, however, be pertinent to reiterate that first of all the *object itself* must attract the attention of the pupils of the class, and *not* the general relations and principles which the object is supposed to represent, and which can by means of the higher powers of reasoning be deduced from it. To illustrate what is here meant, a case in point is cited. A teacher was using a squirrel as an object lesson. Unfortunately it was not a real living squirrel but a well executed picture instead. The teacher laid especial stress upon the qualities belonging to squirrels that are similar to certain qualities in children and called attentention to similar relationships, but failed to pay any definite attention to the squirrel in and of itself. Consequently when one of the brightest pupils was asked the size of the squirrel, the reply was given: "About so big," holding her hands out almost three feet apart. On further questioning it was found that she seriously thought that a squirrel was "As big as a little boy or girl." It is decidedly better to lay the emphasis upon the object itself in the first stages of this form of teaching. The following is a case right in line with this suggestion. A teacher, who had become thoroughly tired of some of her pupils saying that butter grew on ice, or was made of eggs, or grew on butter cups, took the right method to clear their minds of such notions when with a little toy churn she made a thimbleful of butter at school in the presence of her pupils as an object lesson.

The object lesson could be extended to every department of instruction and should cover a wide range of facts. Do not limit yourself to the contents of home or schoolyard, but include the forest and field, the river and brook, the seashore and stone quarry. For the purpose of extending the range of observation for children, we hope that the German custom of school children, accompanied by their teacher, taking long walks into the country, will soon be adopted here in our own land. The trustees and school directors may tell you it is a waste of time for you to take a walk through the woods and across the fields for the purpose of observing and calling the attention of the children to the birds and insects, flowers and trees, leaves and pebbles, but by cautious studied effort you may succeed in effecting an arrangement whereby you are enabled to bring the children into face to face contact with Mother Nature at least once a week. If you succeed your pupils will, in the years to come, rise and call you blessed. But if the powers over you insist that it is far better to read about "Ann's hat," "Ned's top," and "Tom's nag," then do the best you can by claiming, each year, an outing day, e. g., the first of May—to be an *annual field day*. By and by you will, with the coöperation of other wide awake teachers, convince the patrons that training the powers of observation in early childhood is more important than a knowledge of all the capitals and their locations, better for both the child's mind and body than their usual problems in primary arithmetic, and infinitely more valuable than their ability to name the presidents in the order of their election, or whether 1111 men were killed in a certain battle, or only 1110. You can, however, do this much and there is no excuse for you if you do not do it. You can insist on your pupils bringing specimens of leaves, flowers, bugs, rocks, fish, and the like to the school for the purpose of making possible a natural history collection of the animal and vegetable life of the community in which they live. *Every teacher should have a school museum made up almost entirely of interesting objects that the pupils have collected.*

The object lesson can possibly aim at nothing other than the training of the observing powers themselves. But as schools are at present constructed, the best training of the observing powers lies outside the range of school exercises. Higginson again in his own inimitable way speaks to the point here. "In the study of natural history I have heard exercises with 'object-lessons' that seemed to be especially contrived to stultify the human intellect; and this especially in some normal schools, where one young pupil stands up before the others, making believe that she knows everything, and her classmates sit before her making believe that they know nothing. It is necessarily all a form and a 'process.' They go through the questions which the children are supposed to ask about the object; and, of course, if the real children do not ask the right questions, they must be taught to ask them. They must wish to know what they ought to wish to know, not what they really desire. When the young teacher faces real children, therefore, instead of studying their actual minds, she proceeds on a method previously arranged.

Perhaps it is a stuffed bird which she holds up before them. She says, as she has been taught to say, 'Children, what is this?' One boy shouts, 'It's a jay.' Another says, almost simultaneously, 'It's a blue-jay.' Then the teacher explains to them that this is not the proper answer at all. They must answer first, 'A bird,' and then must go on, with due surprise, to the information that it has two legs and has wings; and by and by, after plenty of systematic preparation, they may proceed to the fact that the bird is a jay, and even a blue-jay—all this being something which they knew perfectly well already, but must not be permitted to recognize in any disorderly or unmethodical form. The consequence is that the bright and observing children, who ought to be leaders of the class, are deadened and discouraged, and all the laurels go to the unobservant and stupid, who never noticed a bird in their lives, and would not do anything so unseemly as to pronounce any stuffed object a blue-jay until the teacher had led them up to it by a logical and irresistible process." The training of the child's observing powers is, at least, the chapter in education in which the parent can coöperate with the teacher to the best advantage. In seeking to cultivate the observing powers of your pupil by use of the object lesson and other means, you accomplish four things for him, each one of which is vitally important.

(1) *You make his knowledge more accurate and clearly defined.*

(2) *You make his knowledge more comprehensive and complete.*

(3) *You develop his mental power and intellectual capacity.*

(4) *You make his acquisition of knowledge pleasant and delightful because you follow the natural order—"first the blade, then the ear, then the full* corn in the ear."

LESSON XV.

THE CONTENTS OF A CHILD'S MIND ON ENTERING SCHOOL.

More than twenty years ago an association of teachers in Germany, at Berlin, undertook to investigate the stock of ideas which children possess at the time of entering school.[*]

This was done largely with a view to discover the influence of environment upon mental growth and it was actually found that the city children not only differed widely from those of the smaller towns and country villages, but also that children living in different wards of the same city possessed quite a different stock of ideas, due of course chiefly to environment. For a long time previous to this it was observed that country children who entered the city schools behind the children of the same age, readily caught up with them. This was found to be due chiefly to the fact that the methods of primary instruction were better adapted to country than to city children. It was found that a large mass of children actually go through the world from day to day without observing the most conspicuous objects, such as important monuments, public squares, gardens and parks near their homes and schoolhouse. When asked what mountain (Berg) they had ever seen, all the girls in an upper grammar grade said "*Pfeffenberg*," the name of a beer hall near by. Everyone thought of a "*Berg*" as a place of amusement and not as a natural object. What vague notions their geography lessons must have brought to them. Nearly half the boys and more than half the girls on entering school had never seen, to know by name, any of these three most conspicuous objects in Berlin: Lustgarten, Unter den Linden, the Brandenburg Gate. Space will not permit of the table being printed here in detail—only the more general results. Thus, for example, out of ten thousand children, 9,026 had an idea of dwellings—what they are and for what used; 7,435 of this number were familiar with the significance of the concept "two;" but only 5,853 (a few more than half) knew what "fish" meant; only 3,646 had any notion of the meaning of the term "forest;" the "King's Palace" was clear to 2,886; 2,078 understood the term "lake," while "river" was known to but 1,122. The names of 75 objects were given in the inquiries made of each pupil. Of *three-fourths* of these, more girls are ignorant than boys, and those who had not been in Kindergarten were decidedly more ignorant than those who had. The girls, however, clearly excelled in the following concepts: Name and vocation of the father, the thunder shower, rainbow, hail, potato field, moon, square, circle, oak, dew and Botanical Garden. Of the whole group of children (10,000) the sphere was known to 76%, the cube to 69%, the square to 54%, the circle to 49%, the triangle to 41%. It was found that girls excelled in space concepts and boys in numbers. Girls excelled in ideas of family, house and thunder-storms; children inmates of houses of refuge and reform schools had more ideas than children coming from homes; while those from the Kindergarten excelled both the other groups in their fund of information. It is a burning shame that the child's most used and threadbare question—a veritable "chestnut"—"*What is that?*" should be answered less frequently at home than elsewhere.

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[*] For complete report see *Vorstellungskreis der Berliner Kinder beim Eintritt in die Schuler* (Berlin Städtisches Jahrbuch 1870, pp. 59-77).

Dr. Karl Lange insists, and not without reason, that a child six years of age has absolutely learned far more than a student learns during his university course. "These six years have been full of advancement like unto the six days of creation." Lange himself made some investigations upon the subject of environment as influencing mental "capital." The subjoined table was
sed upon observations of 500 children in the city schools
anen and 300 children in the country schools. The fig-
given indicate the *per cent.* of those having the concept
oned.

TABLE SHOWING IN PER CENTS THE NUMBER OF CHILDREN OUT OF 500 THAT POSSESS THE IDEA HERE MENTIONED.

	The Concept or Idea.	City Children.	Country Children.
1	Seen the sun rise	18	42
2	Seen the sun set	23	58
3	Seen the moon and stars	84	82
4	Seen fish swim	72	83
5	Been to a pond	51	86
6	Been to a brook or river	71	82
7	Been to a high hill or mountain	48	74
8	Been in a forest	63	86
9	Knows an oak	18	57
10	Seen a corn or wheat field	64	92
11	Knows that bread comes from grain	28	63
12	Seen a shoemaker at work	79	80
13	Seen a carpenter at work	55	62
14	Seen a mason at work	86	92
15	Been in a church	50	49

Only 43 per cent of the city children had ever been to any town or village. Their knowledge of colors was as follows, beginning with those best and ending with those least known: black, white, red, green, blue, yellow. The ignorance of city children shows the practical utility of frequent school excursions.

It is interesting to know that in Germany it is more common than in our country to teach school geography by beginning with the schoolhouse and yard, the streets of the city, and then gradually widen out into the world. Holiday walks conducted by teachers for educational purposes are also more common, we are sorry to admit, than here in America.

Of much more value than this work of investigation done in Berlin are the painstaking endeavors undertaken in this country by that leader of educational thought and action, President G. Stanley Hall, of Clark University. The work was done in Boston in 1880 with the assistance of Mrs. Quincey Shaw and Miss Pingree, aided by four teachers. It is needless to add that this work was carried out with the greatest care and thoroughness.[*]

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[*] For this interesting report in detail see Article III, in "Pedagogical Semin *June, 1891*, edited by G. Stanley Hall, of which our account is a résumé.

The following table was based on observations made upon two hundred Boston children shortly after entering school in the fall. The endeavor was made to select pupils of average capacity—neither the prodigy nor the dullard—the child of average intelligence who came from homes not representing either of the extremes of culture or ignorance.

In 1883 Supt. J. M. Greenwood, of the Kansas City Schools, tested 678 children of the lowest primary grade, of whom 47 were colored, with some of the same questions used by Dr. Hall in his Boston tests. It should be observed that the tests on the Kansas City children were made in March, April and May, or after seven months of school life.

The comparisons that may be made between the school children of these two American cities, with respect to their "stock of ideas"—their fund of knowledge—on entering school, are intensely interesting. An actual basis is here supplied for our discussions with reference to the influence of environment upon children, especially in their earlier days. The Kansas City children have, on the whole, more active observing powers than do the Boston children.

Name of the Object of Conception.	Per Cent. of Children *Ignorant* of it.		
	In Boston.	In Kansas City.	
		White.	Colored.
Beehive	80	59.4	66
Crow	77	47.3	59
Bluebird	72.5	....	....
Ant	65.5	21.5	19.1
Squirrel	63	15	4.2
Snail	62	....	....
Robin	60.5	30.6	10.6
Sparrow	57.5	....	....
Sheep	54	3.5	....
Bee	52	7.27	4.2
og	50	2.7	....
g	47.5	1.7	....
icken	33.5	.5	....

Name of the Object of Conception.	Per Cent. of Children *Ignorant* of it.		
	In Boston.	In Kansas City.	
		White.	Colored.
Worm	22	.5	....
Butterfly	20.5	.5	....
Cow	18.5	5.2	....
Growing Wheat	92.5	23.4	66
Elm Tree	91.5	52.4	89.8
Oak Tree	87	62.2	58.6
Pine	87	65.6	87.2
Maple	83	31.2	80.8
Growing Moss	81.5	30.7	42.5
Growing Strawberries	78.5	26.5	1.1
Growing Clover	74	....	....
Growing Beans	71.5	....	....
Growing Blueberries	67.5	....	....
Growing Blackberries	66	....	....
Growing Corn	65.5	....	....
Chestnut Tree	64	....	....
Planted a seed	63	....	....
Peaches on a tree	61	....	....
Growing Potatoes	61	....	....
Growing Buttercups	55.5	....	....
Growing Rose	54	....	....
Growing Grapes	53	....	....
Where are the child's ribs?	90.5	13.6	6.4
Where are the child's lungs?	81	26	44.6
Where is the child's heart?	80	18.5	18.1
Where is the child's wrist?	70.5	3	....
Where are the child's ankles?	65.5	14.1	....
Where is the child's waist?	52.5	14	4.2
Where are the child's hips?	45	14	4.2
Where are the child's knuckles?	36	2.9	8.5
Where are the child's elbows?	25	1.5	....
Knows right and left hand	21.5	1	10.2
Knows cheek	18	.5	....
Knows forehead	15	.5	....
Knows throat	13.5	1.1	....
Knows knee	7	1.6	....
Knows stomach	6	27.2	45.9
Dew	78	39.1	70.2
What season it is	75.5	31.8	56.1
Seen hail	73	13.6	18.1
Seen rainbow	65	10.3	2.1
Seen sun rise	56.5	16.6	....
Seen sun set	53.5	19.5	....
Seen clouds	35	7.3	....

Name of the Object of Conception.	Per Cent. of Children *Ignorant* of it.		
	In Boston.	In Kansas City.	
		White.	Colored.
Seen stars	14	3	....
Seen moon	7	26	53
Conception of an island	87.5	....	....
Conception of a beach	55.5	....	....
Conception of woods	53.5	....	....
Conception of river	48	....	....
Conception of pond	40	....	....
Conception of hill	28	....	....
Conception of brook	15	....	....
Conception of triangle	92	....	....
Conception of square	56	....	....
Conception of circle	35	....	....
The number five	28.5	....	....
The number four	17	....	....
The number three	8	....	....
Seen watchmaker at work	68	30.1	49.7
Seen file	65	20.8	36.1
Seen plow	64.5	13.9	8.5
Seen spade	62	7.3	15
Seen hoe	61	5	10.6
Seen bricklayer at work	44.5	10.1	2.1
Seen shoemaker	25	8.7	....
Seen axe	12	18.4	53
Knows green by name	15	....	....
Knows blue by name	14	....	....
Knows yellow by name	13.5	....	....
Knows red by name	9	....	....
That leathern things come from animals	93.4	50.8	72.3
Maxim or proverb	91.5	....	....
Origin of cotton things	90	35.7	15
What flour is made of	89	34.7	57.4
Ability to knit	88	....	....
What bricks are made of	81	33.1	53
Shape of the world	70	46	47
Origin of woolen things	69	55	44
Never attended kindergarten	67.5	....	....
Never been in bathing	64.5	13.4	....
Can tell no rudiment of a story	58	23.6	12.7
Not know wooden things are from trees	55	19.3	6.4
Origin of butter	50.5	6.7	....
Origin of meat (from animals)	48	8.3	12.7
Cannot sew	47.5	23.4	....
Cannot strike a given musical tone	40	....	....
Cannot beat time regularly	39	....	....

Name of the Object of Conception.	Per Cent. of Children *Ignorant* of it.		
	In Boston.	In Kansas City.	
		White.	Colored.
Have never saved pennies at home	36	8.2	12.7
Never been in country	35.5	13.1	19
Can repeat no verse	28	20	42.5
Source of milk	20.5	4	....

Name of the Object of Conception.	Per Cent. of Ignorance in 150 Girls.	Per Cent. of Ignorance in 150 Boys.	Per Cent. of Ignorance in 50 Foreign Children.	Per Cent. of Ignorance in 50 American Children.	Per Cent. of Ignorance in 64 Kindergarten Children.
Beehive	81	75	86	70	61
Ant	59	60	74	38	26
Squirrel	69	50	66	42	43
Snail	69	73	92	72	62
Robin	69	44	64	36	29
Sheep	67	47	62	40	40
Bee	46	32	52	32	26
Frog	53	38	54	35	35
Pig	45	27	38	26	22
Chicken	35	21	32	16	22
Worm	21	17	26	16	9
Butterfly	14	16	26	8	9
Hen	15	14	18	2	14
Cow	18	12	20	6	10
Growing clover	59	68	84	42	29
Growing corn	58	50	60	68	32
Growing potatoes	55	54	62	44	34
Growing buttercups	50	51	66	40	31
Growing rose	48	48	60	42	33
Growing dandelion	44	42	62	34	31
Growing apples	16	16	18	12	5
Ribs	88	92	98	82	68
Ankles	58	52	62	40	38
Waist	53	52	64	32	36
Hips	50	47	72	31	24
Knuckles	27	27	34	12	23
Elbow	19	32	36	16	12
Right from left hand	20	8	14	20	4
Wrist	21	34	44	9	19
Cheek	10	12	14	14	4

Name of the Object of Conception.	Per Cent. of Ignorance in 150 Girls.	Per Cent. of Ignorance in 150 Boys.	Per Cent. of Ignorance in 50 Foreign Children.	Per Cent. of Ignorance in 50 American Children.	Per Cent. of Ignorance in 64 Kindergarten Children.
Forehead	10	11	12	10	7
Throat.	10	18	14	16	14
Knee.	4	5	2	10	2
Dew	64	63	92	52	57
What season it is	59	50	68	48	41
Hail	75	61	84	52	53
Rainbow	59	61	70	38	38
Sunrise.	71	53	70	36	53
Sunset	47	49	52	32	29
Star.	15	10	12	4	7
Island	74	78	84	64	55
Beach.	82	49	60	34	32
Woods	46	36	46	32	27
River.	38	44	62	12	13
Pond.	31	34	42	24	28
Hill.	23	22	30	12	19
The number five.	26	16	22	24	12
The number four	15	10	16	14	7
The number three	7	6	12	8	0

The tables speak for themselves and are submitted here without comment. Especially noticeable is the fact that Kindergarten children without regard to nationality have the advantage over all others. Most of these children came from a charity Kindergarten, so that superior intelligence and home environments can hardly be assumed. Thirty teachers were questioned as to the difference between children from Kindergartens and other children. Four said no difference was observable, while all the rest thought them better fitted for work, noting especially their better command of language, superior skill with hand and slate, excelling quickness, power of observation, number work, singing, neat- ss, politeness, freedom from excessive bashfulness and, best of l, *love of work*. Some thought them more restless and talka- , and one complained because "children from the kindergar- lways want to know the reason why of everything."

high rate of ignorance exhibited in the table is surprising to most readers of the report. But is it not because we take too much for granted with reference to the knowledge possessed by the children in whom we are more especially interested and with whom we come in contact? I was rebuked and made ashamed of my own neglect when I came to test my little five year old girl with the same conceptions as those employed in the tests on the Boston children. Of course, it would be unnatural for me to say anything else than that she is above the average child in intelligence. The painful surprise came, when, after she had answered nearly every question of the above table correctly, the inquiry was made as to the origin of butter. The answer she gave was—"From buttercups." Some of the Boston children stated that "skeins and spools of thread grow on a sheep's back or on bushes, stockings on trees, butter comes from buttercups, flour is made from beans (quite excusable in a Boston child), oats grow on oak trees, bread is swelled yeast, meat is dug from the ground, and potatoes picked from trees. Cheese is squeezed from butter, the cow says 'bow-wow,' the pig purrs, bricks are the same as stones, etc."

We cannot do better than to quote at least two of the conclusions reached by Dr. Hall to the effect that:

1. There is next to nothing of real educational value, the knowledge of which it is safe to assume at the beginning of school life. Hence, the need of objects and the danger of books, word cramming and rote learning.

2. The best preparation parents can give children for real valuable school learning is to make them acquainted with natural objects, especially with the sights and sounds of the country, and send them to good, common-sense kindergartens. "A country barn or a forest is a great school at that age."

In a recent number of the "Outlook" the following pertinent paragraph appears under the caption, "A Public Benefactor:"

"A teacher in one of the public schools in Brooklyn has offered a prize for the best collection of leaves made by her pupils. It is said this has created an intense interest in botany in her class, which shows itself in very much better text-book work. Squeers forestalled education by a great many years when he taught the boy to spell "horse," and then go and curry one. One of the pathetic things about our system of education, when the teacher is a teacher from necessity and not from choice, is that the pupil literally goes through the world having eyes and seeing not, and having ears and hearing not, because the power that is within himself is not developed. He is too often made a receptacle for words—a human phonograph, who is expected to give back just what has been put in, in its original form, not changed by the individual use he has made of those words. The teacher in Brooklyn may never be known by name, but she certainly will leave her impress on the plastic germ of immortality intrusted to her care. It is safe to say that her boys will not spend their summer vacations playing billiards, nor her girls embroidering purple dogs against a green sky when they reach maturity. The woods will offer them more interesting objects than Broadway."

That children at the age of six have ideas of right and wrong was certainly evinced by the Boston tests. Each child was asked to name three things wrong and three things of which right can be predicated. In not a single case were the two confused or interchanged. Boys say it is wrong to steal, fight, break windows, get drunk, "sass" or "cuss," while girls intimate it is wrong not to comb their hair, to get butter on their dress, to climb trees, to unfold the hands, or be "Tom boys." Wrong things are more frequently specified than right, showing among other things the sad fact that children are more often told what they *must not* do than they are informed as to what they may do.

Another extended inquiry has been made since the attempts in Boston. It was that of Dr. Hartmann undertaken in Annaberg, Germany, in order to gain some light upon the question as to what is the best natural basis of primary school instruction. These tests extended over a period of five years on as many groups of children and the vigor and enthusiasm with which they were prosecuted caused similar tests to be undertaken in other German cities. The course since mapped out at Annaberg for the *first two* years of school life finds its basis in the results of these experiments. So valuable have these tests been found to be, that they are now undertaken each year in various cities whose eyes are open to the best development of the children's mental life. One Normal School, that of Jena, begins each year with similar investigations into the children's sphere of thought. Who can predict what delightful and beneficial changes would be wrought in the prevailing methods if tests were made in at least 100 representative localities of our country. What a comment the results would be! How quick we would be to insist that methods of teaching be adopted which would be better suited to the average child mind and increase his stock of ideas, train his senses and make more possible his final emancipation from the thraldom of ignorance, so that in him there could be realized the ideal, complete, well-rounded development which should be the lot of every individual.

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LESSON XVI.

THE ILLUSIONS OF SENSE.

Thus far we have considered only the thought processes of the normal person in his wakeful moments. In several of the previous chapters, in which the various sensations have been the subject of discussion, little or nothing has been said of the illusions of sense. By illusion, in the broadest sense of the word, is meant *mental deception*. In its more restricted meaning, it indicates a *mistaken* subjective or mental interpretation of an objective impression, as when the charred, blackened stump at the roadside, is taken for a crouching highwayman, or the perfectly square, plane figure appears higher than it is wide, or the lady's hand appears smaller clothed in a black than in a white glove.

Illusions must be distinguished from hallucinations. In the illusion, there is actually present some objective stimulus which is somehow misinterpreted, in consequence of which, we have a wrong picture of the object as it actually exists. On the other hand, in the hallucination there is no objective stimulus at all. This difference is made more clear and definite by illustration. I am fishing. The trolling line is out, the spoon is twirling, my thumb is on the reel seat with fingers ready to "reel in"—all is expectancy. Suddenly, I feel a jerk at the line, the flexible tip of the rod is bending, I cry out exultingly "a strike." I reel in a few feet and reluctantly am compelled to admit that I was deceived by a bunch of weeds getting on my hook—*an illusion of sense.* The jerk at the line was an actual objective stimulus, but was misinterpreted to be the bite of a muskellunge instead of a bunch of weed. This is a case of sensory *illusion.* The voices one hears in his troubled dreams, the monsters one sees in a terrible *nightmare, the* dagger of Lady Macbeth—("Is this a dagger I see before me?")—all these, in that they are products of fancy's creating power and not based upon real objectively existing voices and shapes, are *hallucinations*. Thus, it is said, the poet, Goethe, was able, when his eyes were closed and his head inclined, to see a flower, out of which other new flowers kept growing for as long a time as he liked.

Some writers insist that the treatment of the interesting phenomena grouped under the class-names, hallucinations and illusions, lie outside of the province of the psychologist. But you will recall that at the outset, in the very first pages of this book, it was claimed that in order to know what mind is we must know what it does. The real work of the student of Psychology is to discover the nature of mind as it unfolds and reveals itself in the activities of daily life. The study of illusions throws much light on the subject of sense perception, showing conclusively that the mental element in every perceptive act, is an important and essential factor. No fair-minded student will close his eyes to a single fact that will shed the least ray of light upon the nature of the subject he is investigating. In the present volume we are seeking to discover the nature of mind. We can do this only when we patiently investigate into all the activities through which mind manifests its nature. Illusions of sense are especially characteristic of the child mind in the imaginative period. Of all persons, the teacher and parent ought be acquainted with the fact that all individuals do not see the same object in the same way. Though the same object may make the same image on the retina, this objective stimulus will be differently interpreted by each individual whose sensorium is affected. The perceptions of no two individuals are exactly alike, be they induced by the same visual, auditory, touch, smell or taste impressions. Two travelers, both thoroughly honest, will give quite different accounts of the same object, viewed abroad, because each perceived this object differently. The beautiful forest with its gigantic trees, dense shade and graceful trunks will make three distinct impressions on as many persons. The lumberman will enter the forest with his cool, commercial eye, calculating the number of logs that could be cut from this oak or that hemlock, the number of "board-feet" that each will yield, and so on; the tired, hot, dusty traveler will appreciate most of all its delightful shade, the soft mossy turf that makes such a restful couch upon which to recline—little cares he whether the tree over his body is a beech, pine or sycamore; on the other hand, the artist, with his sketching paper, looks at the trees with respect to the blending of color, their outline and general æsthetic effect. Do you not readily see that these three men will carry away in their minds, very different pictures of this same forest? You are, no doubt, familiar with the old time jingle which relates the story of

THE BLIND MEN AND THE ELEPHANT.

It was six men of Indostan
To learning much inclined,
Who went to see the elephant
(Though all of them were blind),
That each by observation
Might satisfy his mind.

The first approached the elephant,
And, happening to fall
Against his broad and sturdy side,
At once began to bawl:
"God bless me! but the elephant
Is very like a wall!"

The second, feeling of the tusk,
Cried: "Ho! what have we here,
So very round and smooth, and sharp?
To me 'tis very clear,
This wonder of an elephant
Is very like a spear!"

The third approached the animal,
And, happening to take
The squirming trunk within his hands,
Thus boldly up he spake:
"I see," quoth he, "the elephant
Is very like a snake!"

The fourth reached out his eager hand,
And felt about the knee.
"What most this wondrous beast is like,
Is very plain," quoth he;
"'Tis clear enough the elephant
Is very like a tree!"

The fifth, who chanced to touch the ear,
Said: "E'en the blindest man
Can tell what this resembles most;
Deny the fact who can,
This marvel of an elephant
Is very like a fan!"

The sixth no sooner had begun
About the beast to grope,
Than, seizing on the swinging tail
That fell within his scope,
"I see," quoth he, "the elephant
Is very like a rope!"

And so these men of Indostan
Disputed loud and long,
Each in his own opinion
Exceeding stiff and strong,
Though each was partly in the right,
And all were in the wrong!

So it is with children in our schools—with their organs of sense differently developed, they each look at a new object from a different point of view. Teachers and parents are apt to forget this and censure children accordingly. This brings out the other fact that illusions are not all uniform. The illusion that occurs to one person may not be so perceived by another. The most important fact to remember is that illusions do occur, and that teachers and others should accordingly make allowance for them. One of the most humiliating experiences that I have to remember, one which harrows my soul to this day, though it occurred years agone, was due to a quite common optical illusion. When less than sixteen years of age, I was given charge of a large, ungraded, district school. One of the twenty-five classes I was compelled to teach each day was Plane Geometry. I had always noticed that the squares drawn by the pupils looked higher than they did wide. This seemed to occur so regularly that I cautioned the pupils that they measure accurately the lines, especially in drawing square figures. The next day the squares drawn by the same pupils still looked higher than wide. This fact so nettled me that I "lectured" the class severely because they did not draw their squares *square*. Fate seemed to decree that I should learn a lesson then and there, for I was suddenly seized with the notion to measure the lines before their very eyes that they might see how serious their mistakes actually were — when lo, I discovered that I, myself, was at fault — the squares were perfectly drawn—and I had to back down as gracefully as I knew how. This experience is related on the basis of the old trite saying that "an honest confession is good for the soul."

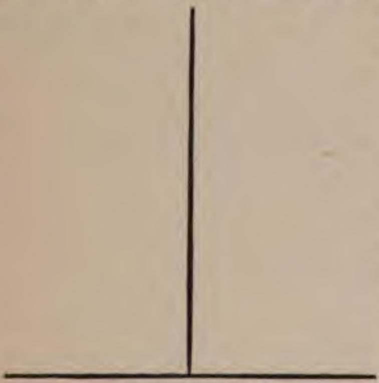

FIGURE 24.

When comparing magnitudes in the upper part of the field of vision with those in the lower, one overestimates the former. The upper and lower half of an "S," "B," "X" or a figure "8" appear of nearly the same size, but when they are inverted ("S," "ꓭ," "X" and "8"), the difference in the size of the two halves is exaggerated.

A vertical line appears longer than a horizontal line of the same length—at least to a large majority of persons. (See Fig. 24.) This is because greater effort of the eye is called for in order to see a vertical line than is required to see one that is horizontal. The vertical line seems longer for almost the same reason that a mile up hill seems longer to the traveler than a mile over a level stretch of country—it takes more effort to get over the ground. A square whose height is diminished by at least one fortieth seems perfectly square to the eye of so good and well-trained an observer as Helmholtz.

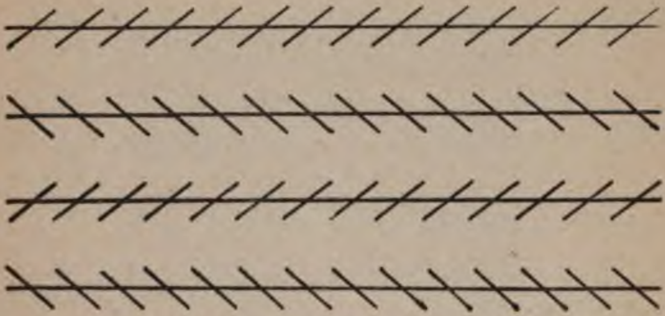

FIGURE 25.

Illusions are of frequent occurrence—all persons are subject to them, and they appear in connection with every one of the senses. The optical illusions are probably the most common and will first receive our attention. In Fig. 25 (first described by Zöllner, and known as Zöllner's lines) the four, long, main (horizontal) lines are actually parallel, though they by no means appear so. They seem to be very far from parallel, each adjoining pair of lines seems to diverge at one end and converge at the other. In Fig.

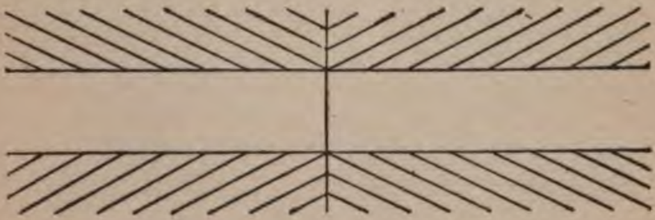

FIGURE 26.

26 we have practically the same illusion in another form; also in Fig. 27.

In Fig. 28 and Fig. 29 we have the optical illusion known commonly as the illusion of discontinuity.

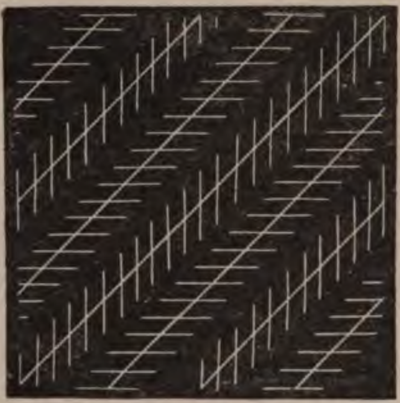

FIGURE 27.

In A of Fig. 28, *a* appears continuous with *c*, but is really so with *b*. This is especially emphasized in B (Fig. 28), in which the actually continuous line *ab* appears to be deflected once in one direction and again in the opposite direction. When two unequal angles together make 180°, the acute angle appears relatively *larger* and the obtuse angle relatively smaller than should be the

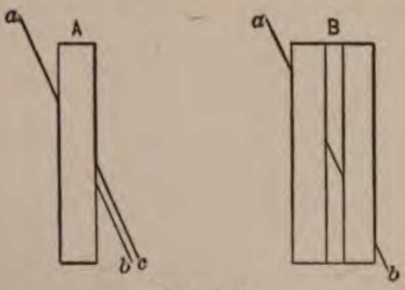

FIGURE 28.

case. Thus in A of Fig. 29, *c* seems continuous with *a*, while *b* is really so; this is because the lower obtuse angle is made smaller than it really is.

We are also greatly deceived by the apparent length of lines.

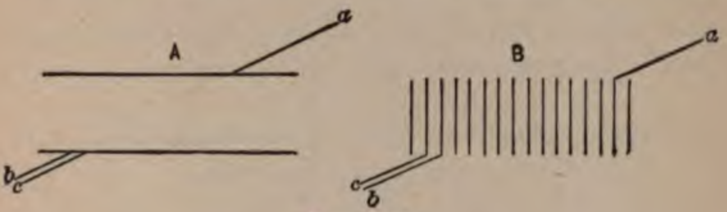

FIGURE 29.

We have already referred to the fact that a vertical line appears longer than a horizontal line of the same length. This has been shown in Fig. 24. In Fig. 30 the horizontal portions of I, II, III and IV are all the same length. The greater the angle at the extremity, the greater is the apparent length of the line.

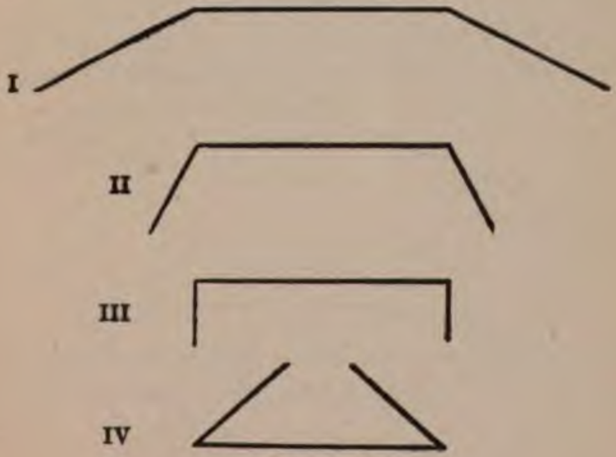

FIGURE 30.

The same influence seems to obtain with reference to the pair of horizontal lines *a* and *b* in Fig. 31, and the pair of horizontal lines *x* and *y* in Fig. 32, which are exactly the same in length, though they by no means appear so.

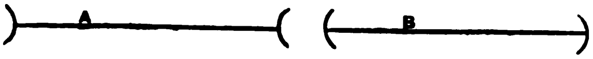

FIGURE 31.

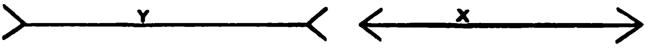

FIGURE 32.

The presence of the lines themselves has nothing to do with the optical illusion, as is shown in the cut (Fig. 33) where the lines are omitted. This seems to show conclusively that the illusion is due to the fact that we overestimate small angles and underestimate large ones. That angular inclination is the decisive factor is shown best of all in Fig. 34, where the continuous line is

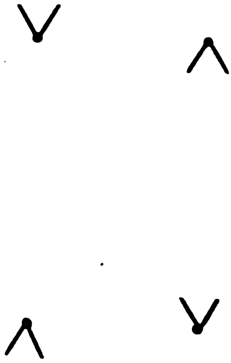

FIGURE 33.

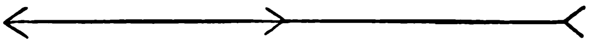

FIGURE 34.

bisected, exactly at the middle point, though the two parts do not *appear* equal.

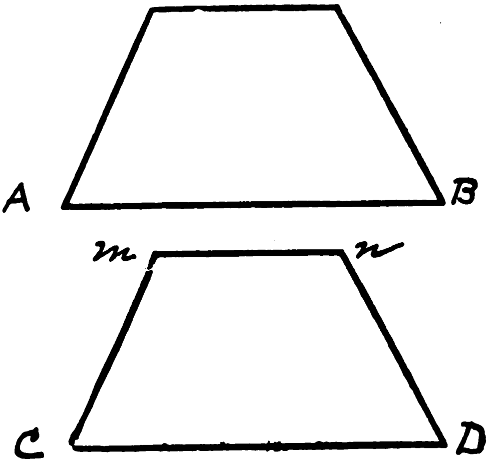

FIGURE 35.

With most persons the two areas in Fig. 35 would be judged unequal. To the majority of persons the upper figure in the cut ap-

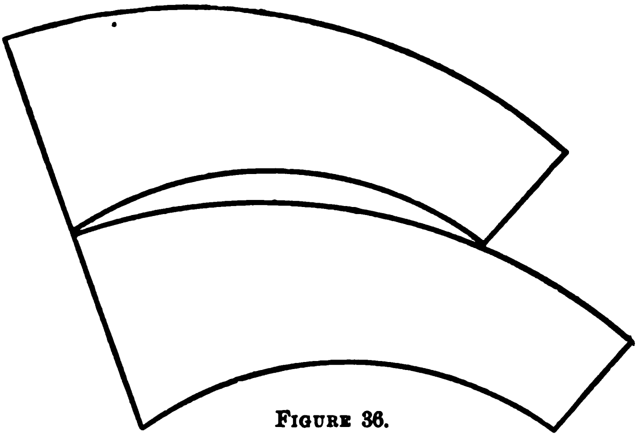

FIGURE 36.

pears larger than the lower one. We judge the two areas by means of their juxtaposed lines. The upper figure seems the larger because its longer side (the base line, AB) is brought into contrast with the shorter side, *mn*, of the lower figure. It is a well-known fact that a square resting on one of its corners is apparently larger than an equal square resting on one of its sides, because we then contrast the side of the one with the diagonal of the other square. The illusion in Fig. 36 rests upon the same underlying principle as that represented in Fig. 35, the lower figure seeming the larger, and quite clearly so.

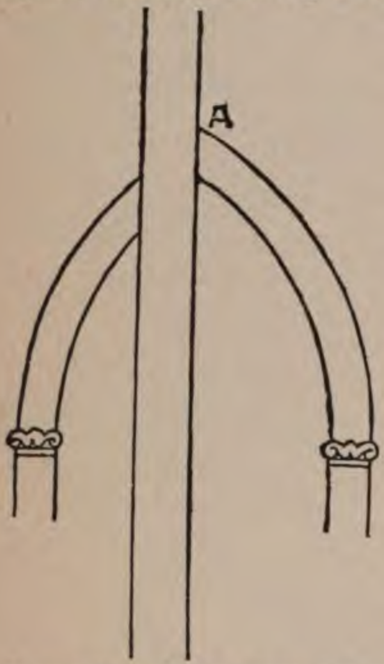

FIGURE 37.—AN ARCH UNSYMMETRICALLY DIVIDED.

The cut (Fig. 37) represents a gothic arch bisected at one side by a straight column, the apex of the arch being at A. On looking at the two sides of the arch it will seem impossible that both can be of the same degree of curvature, or that the lines of the shorter side, if extended, will join those of the longer one. It can, however, be very easily proved by drawing two lines with a pencil across the straight bisecting lines, when the arch will at once appear in its proper form, although until this is done the eye refuses to perceive the fact, and the appearance of two dissimilar arches persists. This illusion is of practical importance to architects who in planning buildings with arches, should avoid placing columns in such a position that the arches will be unsymmetrically divided by them.

Drapers, furnishers and decorators in making the ceiling of a room appear higher or lower, or the room itself appear larger or smaller, take advantage of certain optical illusions. Likewise the dressmaker. No stoutly built woman could be persuaded to wear a striped dress so made, that the stripes run horizontally around her body. Neither will she wear a large figured plaid.

"The Proof Reader's Illusion" is one of the more common forms of illusion experienced. Printers will read common words aright when spelled wrong simply because of the element of expectancy. The typographical errors occur as a rule in connection with common words, and are not found in connection with unfamiliar, unusual or extraordinary words. The familiar words are read as wholes by the proof reader, while the unfamiliar words are read a letter at a time. Professor James relates an experience which is very pertinent in this connection: "I remember one night in Boston, whilst waiting for a 'Mount Auburn' car to bring me to Cambridge, reading most distinctly that name upon the signboard of a car on which (as I afterwards learned) 'North Avenue' was painted. The illusion was so vivid that I could hardly believe my eyes had deceived me. All reading is more or less performed in this way."

Professor Lazurus tells us that "practised novel, or newspaper, readers could not possibly get on so fast if they had to see accurately every single letter of each word in order to perceive the words. More than half of the words come out of their mind, and hardly half from the printed page. Were this not so, did we perceive each letter by itself, typographic errors in well-known words would never be overlooked. Children, whose ideas are not yet ready enough to perceive words at a glance, read them wrong if they are printed wrong; that is, right according to the printing. In a foreign language, although it may be printed with the same letters, we read by so much the more slowly as we do not understand or are unable promptly to perceive the words. But we notice misprints all the more readily. For this reason Latin and Greek, and still better Hebrew works are more correctly printed, because the proofs are better corrected than in German works. Of two friends of mine one knew much Hebrew, the other little, the latter, however, gave instruction in Hebrew in a Gym-

nasium [as the Germans call their academic schools], and when he called the other to help correct his pupils' exercises, it turned out that he could find out all sorts of little errors better than his friend, because the latter's perception of the words as totals was too swift."

This tendency, so prevalent, of perceiving optical illusions is also made use of in every spiritualistic seance where the "fake" medium deludes the bereft inquirer into believing that he actually sees the spirit of his departed wife, mother, sister or child. The mental picture he has of his loved one, the yearning to catch just one glimpse of her face (in which the "wish is father to the thought"), the bewilderment that comes with the semi-mysterious surroundings, the darkened room and the gauze enveloped figure, all conspire in making him clothe the figure that appears with the form of face and quality of expression that his own loved one possessed during her natural life. In other words he sees what he so much desires to see. For something of the same reason criminal courts are very slow to take at face value the testimony of an interested party as to the identity of a person supposed to have committed a crime. This is especially true when the witness is in an excited condition or was, at least, when the crime was committed. So anxious to have the criminal detected and so desirous of having a part in this detection, such a person is liable to error no matter how positively he may swear or affirm with reference to the identity of the suspected person and his connection with this or that particular crime. When the writer was a boy of twelve he was a forced spectator at a negro lynching. The victim of the mob's fury was declared guilty of crime simply on the basis of his being identified as the criminal by a little girl of five years of age, who was at the time in a highly excited condition. It afterwards transpired that the man was entirely in-
ocent of the crime for which he was executed.

We are all subject to certain peculiar illusions of movement.
re seated in a twisted swing and it is made to rotate and
denly stopped you have a sensation of movement in the
direction. At a railroad station when seated in a car

expecting the train to start it is difficult to tell, when we see objects move past the car windows, whether it is our train that moves or the one alongside that in which we are seated. Similar illusions are noted when we take passage in an elevator or are seated in the cabin of a ferry boat.

In discussing the sense of hearing in a former chapter, your attention was called to the fact that we are very apt to misjudge the direction of sound. This illusion is shown very clearly in the "Punch and Judy" exhibitions, so common a few years ago at county fairs, dime museums and street shows, in which the ventriloquist talks without moving his lips, and at the same time draws our attention to a doll or two whose lips he moves by a little spring. We at once locate the source of the sound within the doll.

You have no doubt been present at a play where an actor who is entirely ignorant of music is required in the plot to play on the mandolin or banjo. He simply goes through the motions before our eyes, while some one behind the scenes or in the orchestra actually does the playing. But because our attention is fixed upon the actor, it is almost impossible not to hear the music as due to him and proceeding from that precise locality of space in which he is standing.

The illusions of touch are very frequent. They consist simply of a touch stimulus occurring at one portion of the body being interpreted as arising from an entirely different locality. Besides the mere modification or confusion with reference to locality of the stimulus, there is also oftentimes a change in the quantity and quality or tone of the touch sensation. If some one touch you at any given point on the skin of the forearm and you try to indicate the same identical spot, you miss it by considerable. I remember a peculiar case of translocation of touch stimulation that once happened in my own experience. There is nothing more disagreeable to me than to have my face touched with woolen cloth of any kind—a piece of flannel or a blanket. Once while watching by the bedside of a sick friend my hand unconsciously slipped from off the table by the bed and touched the woolen blanket which formed part of the covering. Immediately, I felt the disagreeable touch of the blanket on the left side of *my face and not on my hand*, where the touch actually occurred.

A common illusion is connected with the movement of a point or object on the skin. Of two objects moving on the skin at the same time and at the same rate, the heavier one appears to move the faster.

If two points kept equidistant from each other, be drawn over the skin, for example, across the face, so as to describe parallel lines (*ad* and *be* in Fig. 38), the person experimented upon will feel the two points diverge near the mouth, as shown in the accompanying figure.

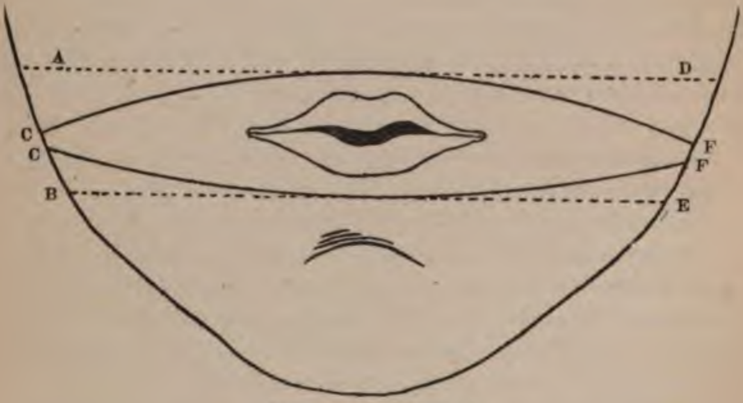

FIGURE 38 (WEBER.)

The dotted lines represent the actual course of the points, while the unbroken curved lines indicate the course as felt.

Attention has already been called to the fact that we frequently experience secondary sensations—that is, a single strong sensation (primary) will be accompanied by another totally different, both as to quality and intensity. The already mentioned phenomenon of color audition in which definite color sensations are evoked by a sound stimulus, also the cases instanced in which letters, words and figures are colored, would naturally be grouped under these secondary perceptions. These color sensations can be evoked by taste and smell stimulations as well as by visual and auditory means of arousement. I have a pupil in one of my university classes, who associates colors with taste, and cannot rid himself of these secondary and illusory sensations. For example, to him the taste of melon is "green," that of the apple is "red," while beans taste "brown," etc. I know a German professor who always has an acute sensation of pain in his shoulder every time he sees a yellow light—a real pain from which he suffers excruciating agony—nevertheless a pseudo-sensation, or better, a secondary perception.

And so we might go on, but a sufficient number of facts have been adduced to show that we are all subject to illusions of sense. From your own fund of experiences you can call up many such illusions that illustrate the point under discussion much better than the examples I have here instanced.

In hallucination, as distinguished from illusion, all objective stimulus is wanting. In hallucination the mental picture is purely a creation and projection of mind. In normal life perfect hallucinations in the strict sense are exceedingly rare. That they do occur is vouched for by the hundreds of well authenticated cases reported to the "Society for Psychical Research," not only in England and Germany, but also in our own country. Illusions are the experiences of most people; hallucinations of comparatively few. The following case recently came to the knowledge of the writer, and is thoroughly vouched for, but has never been published as yet. The parties concerned in the narrative are all well known to the writer. Mr. B., a man 45 years of age, utterly devoid of sentiment, very matter-of-fact, cool-headed and business-like, is a large lumber dealer in Ohio. One morning he was walking through a piece of timber which he had purchased a short time before, and was engaged in directing the lumbermen as to what trees should be cut and how long the logs should be; where the oak, hickory and walnut respectively should be piled, etc. While in the very midst of this work of directing his men he heard a voice like that of his daughter calling, "Father!

come, help me!" He was observed to grow very pale by his foreman and others standing near, but no one could divine the cause as he himself said nothing. He dropped his work, though it was only in the middle of the forenoon, drove to his home in the neighboring town and lay down from mere exhaustion. His wife noticing his strange appearance, so very unusual, as he had never in his life been ill, sent immediately for the family physician. To the physician Mr. B. confidentially related, for the first time, what had occurred in the woods. A few moments later a messenger boy brought a telegram which stated that his daughter (who had been visiting at Columbus for two weeks, and who was expected home the following Saturday evening) was smitten with typhus fever, and requesting that he come at once to her bedside. He did so, finding her delirious, and that she had been calling for her father ever since ten o'clock that morning—*the very same hour* at which he heard the voice so clearly, when in the timber no less than forty miles away.

While such hallucinations are very infrequent so far as normal, healthy persons are concerned, they are exceedingly common occurrences with the insane, and like illusions proper, they occur within the realm of each of the senses.

With regard to the relative frequency of hallucination of each of the senses as compared with each other, they occur in the following order—hearing, sight, taste, touch (including muscle sensations), and smell. This is certainly the order of frequency among the insane, though some writers maintain that among the sane, visual hallucinations are more common than those of hearing. As yet, however, there is not sufficient evidence with which to substantiate any such claim.

Among auditory hallucinations the hearing of voices is the most common, and oftentimes these voices assume the character of a mandate, in which case they become exceedingly serious. Many
dal and suicidal acts perpetrated by the insane can be at-
to the commands of these imaginary voices. Some
do nothing whatever, even the most inconsequential
t consulting an imaginary friend of whom ques-

tions and directions are asked, and replies received, resulting in implicit obedience. Even if the hallucinatory command be to abstain from food, to lacerate the flesh, to commit a crime—no matter what—it is faithfully carried out and realized in action.

These hallucinations of hearing often occur in deaf people; indeed, imperfect hearing is sometimes the real cause of the disorder.

Among the visual hallucinations, the most frequent forms seen are faces, sometimes horrible, grotesque, and terrible in expression, even so much so as to cause an epileptic seizure. That the retina is not the seat of these visual perceptions is shown by the fact that hallucinations of sight may occur when the optic nerves are atrophied and the person totally blind.

The taste hallucinations are of importance since with the insane they frequently suggest that the food has been tampered with. Patients often refuse to take food as a result of these hallucinations of taste, because they are coupled in their minds with some conspiracy or plot.

Hallucinations of smell may be either pleasant or unpleasant, more frequently the latter. Hallucinations of smell may be due to lesions in the brain, or to some disease in the sense organs. Any sort of lesion in the tempero-sphenoidal lobe [in which the hearing center is located], is very apt to produce hallucinations of smell. The pleasant smells are chiefly those of flowers or the artificial odors of colognes and perfume extracts.

Among tactile hallucinations must be included those of common feeling—the organic and muscular sensations. Some insane patients complain of painful sensations which are totally subjective in their origin. The hypochondriac is familiar to us all. The hallucination sometimes takes the form of a delusion with reference to the transformation of themselves, of their physical organism into some other substance than their body. It is not so very infrequent that a patient claims that he has become petrified, or is transformed into wood or glass. The writer remembers a patient who believed his right arm to be of *glass* (and he wasn't a base ball pitcher either). Another patient came under my observation who thought her entire body had been transformed into glass and she would not turn her head or open her mouth, even absolutely refusing to eat, for fear she would *crack her face.* Another patient refused to wash his hands in water, for fear the water would induce decay since his hands were *made of wood.* He didn't seem to realize that decay was all the more sure if he failed to perform his ablutions.

Hallucinations, and illusions also, may be caused in the sane by alcohol, those of sight being the most frequent. Opium, belladonna, Indian hemp, etc., are known to produce similar effects. It is exceedingly rare that hallucinations of more than one sense are observed in the same person.

LESSON XVII.

HABIT.

A statement of M. Leon Dumont, expresses a well-known law of nature. It is to this effect: "Every one knows how a garment after having been worn a length of time, clings to the shape of the body better than when new. There has been a change in the fiber and this change is a new habit of cohesion. A lock works better after having been used for some time. At the outset more force was required to overcome certain roughness in the mechanism. The overcoming of this resistance is a phenomenon that is met with in every department of nature. It is a phenomenon of habituation. It costs less trouble to fold a paper when it has been folded already; and just so with the nervous system, the impressions of the outer world fashion for themselves more and more appropriate paths, and these vital phenomena recur under similar excitement from without, when they have been uninterrupted for a certain time."

This, then, is a general statement of the philosophy of habit. It touches not only the department of mind, but of body and external nature as well. All the recent writers admit the physical principle which lies at the basis of our habitual activities. There is no chapter in Psychology that is of more importance to the teacher than that which deals with the habitual activities of the individual, especially of the child.

You will remember that in a previous chapter the assertion was made, and clearly demonstrated, that body and mind are intimately associated, that mind influences the condition of the body, and that the states of body influence the mind in its nature and functions. This is demonstrated with especial clearness when we come to speak of habit.

Just as a dislocated finger, a sprained ankle, or a broken limb are

in danger of being dislocated or broken again; just as a scar is more liable to become inflamed and suffer pain and cold, than are the neighboring parts; just as tissue that has once been attacked by different forms of disease is more subject to a recurrence of the disease than any other; so it is with those activities in which the body has once been engaged under the control of the will, they take place more easily and with greater facility and exactness, than movements that are just newly initiated. This is especially true when we come to speak of the nervous system, that portion of our organism which is more intimately concerned with the mental activities than any other. If a certain one of our sense organs is stimulated, *e. g.*, the eye, ear, or the hand, and that stimulus is carried to the brain to be expressed in terms of sensation, by traversing a certain path, a second stimulus is more likely to follow the path of the first, than any other possible path, provided the conditions remain the same. Let us illustrate: The first ray of light that enters the child's eye and passes through the lens and humors, follows its course along the optic nerve to the brain, but pursues the path of least resistance and the nervous impulse terminates in a given brain center. Now the second ray of light that stimulates the child's eye (provided the conditions remain the same) does not evoke a nervous impulse that will take a new route, but the path previously followed will be the one selected in the second case. So in the early life of the child, when the brain is plastic and these sensation impulses are continually coming in from the surface of the body, certain paths are clearly determined beforehand, which become more and more fixed, more clearly defined, and more permanent, as the activities of the child increase,
his age advances.

not only the impulses that are *carried in* make permanent
for themselves, but also those impulses that find expres-
certain movements of the body (the acts of will) also es-
ch paths. For example: If my hand is touched with
on, as quick as the sensation is experienced, the hand
wn from the painful stimulus. In withdrawing my
he hot iron, I make a certain definite movement. If

at a later time my hand and the red-hot iron should again be brought into close proximity, I am more apt to withdraw my hand in the self-same way that I did before, rather than to initiate a new kind of movement.

You have noticed the same thing in the practical activities of daily life, not only in man, but in the higher animals. The horse that has occupied a certain stall in a stable for a considerable length of time will, when left to his own free choice, go to the same manger from which he has eaten for so long a time rather than to any other. It is only by great effort, and even severe punishment, that he can be taught to occupy other quarters. The dog insists upon sleeping in the same corner and upon the same mat that has been his for so long. A warmer and more comfortable place has no attraction for him. He feels more satisfied with the old set of conditions. If we have made our home in the self-same building for a long period of time, we find ourselves absent-mindedly walking to the same house, showing that the habit of making that place our destination is deep-seated and fixed in the organism itself. I know a little child that had been permitted in its early infancy to hold a handkerchief in her hand as she lay in her crib. After having done this for some time, it was noticed that she always asked for that knotted handkerchief before she could go to sleep. She somehow came to consider that that particular handkerchief and the phenomena of sleeping were intimately and directly associated, so that until the time she was eight years of age it was found impossible for her to attain normal sleep without holding the handkerchief in her hand. This is an extreme example showing how little things, that take their rise in a purely incidental manner, become registered upon our organism and so deeply seated, that only supreme effort and continual endeavor, at great inconvenience, will eradicate them.

As already intimated, the question of habit is one of great importance and deep significance for every teacher as he comes in contact with the child mind. This is more clearly shown when we come to consider the practical effects of habit.

(1) *Habit always diminishes* the amount of conscious atten-

tion with which our acts are performed. The pianist, in first learning to play his instrument, finds that each movement of the fingers must be closely attended to, that the relative position of the keys must be closely observed, and even then he is continually making mistakes; but after a given amount of practice, when these muscular movements have become habitual, he can play while following conversation or attending to something else. He simply glances at the musical score and his fingers perform the necessary movements.

The hunter, as he stalks the deer through the forest, seeing his game break suddenly into his field of vision and come within rifle range, raises his gun, aims and shoots before he is really aware of having done so. His organism has become trained so that it will respond to such a stimulus invariably, and without a large amount of conscious attention. The sight of a deer always means to him, the raising of the gun, aiming it and the discharge of its load.

Even in our simplest and most instinctive activities, we find that we are more and more facilitated in carrying out these movements when they have become habitual. For example: The child in learning to walk, first attends to each movement that is necessary to locomotion. His eye selects the spot where he wishes to put his foot, and also watches the foot as it is placed forward in the chosen position. Every gentleman tips his hat on meeting a lady, but he does it without thinking just how the necessary movements of the hand and the arm are to be made. The *modus operandi* is not the object of his conscious attention to any extent. He could not describe the exact manner and movement in which he has performed this simple action. This and similar examples go to show that the amount of conscious atten-
n that accompanies our habitual movements is very small.
is a very significant fact, for we know that attention means
, and if habitual movements are performed with little or no
attention, it is the same thing as saying that they are
ittle or no conscious effort. This brings then to our
er important consideration.

(2) *Habitual movements are less fatiguing than the other activities of which we are capable.* If certain activities are performed through habit, we find that there is less wear and tear than if the movement belonged to another category. This is based in a measure upon what we said at the outset concerning the fact that each successive stimulus of an end-organ of sense tends to follow the same path that was taken by the initial sensation, because this is the path of least resistance. As the schoolboy's sled goes down the hill with greater ease and speed after the path has been well worn than it did when first broken, so our sensations come to follow accustomed paths with greater facility and directness. *It is a principle of mental economy that as many as possible of our activities should become habitual.* To present the matter in a crude way, we may say that a well-ordered system of habits constitutes the greatest labor-saving device that could be furnished the mind. But there is yet another principle of which, as teachers, we ought to take cognizance. It is this:

(3) *Habitual actions are performed not only with less effort but in less time than are other activities.* Not only is the attention lessened and the feeling of effort diminished, but the act that is performed through habit is performed in a smaller time interval than that required for those activities which result from deliberation and choice. Do you not see then that it is of the utmost value and far-reaching significance that there be instituted in the child's mind certain habitual modes of thought, so that his mental exercises may be done at less expense to the capital invested—his developing mind and his body as they together unfold their latent powers? The good, old grand-dame, as she knits in a purely mechanical way, talking continually, seems to knit without any great amount of effort, certainly without any degree of conscious attention; but if she should happen to drop a stitch she is at once aware of the fact, so you see that after all, the mind is following a seemingly mechanical activity and is aware of each movement, exercising its dominion over these movements with an exceedingly small amount of effort, but with the keenest precision.

We should also make mention of one other consideration that is exceedingly important:

(4) *Habitual movements are more precise than are our other activities*—that is, an act that is done through force of habit, as we say, is performed in a more exact manner than if done with a large degree of conscious attention and mental supervision.

We now come to some of the more practical considerations that cannot help but have weight with every instructor, for no teacher should be unmindful of the pedagogical importance of the principle of habit. As Professor James so forcibly relates: "Habit is the enormous fly-wheel of society—its most precious conservative agent. It alone is what keeps us all within the bounds of ordinance, and saves the children of fortune from the envious uprisings of the poor; it alone prevents the hardest and most repulsive walks of life from being deserted by those brought up to tread therein. It keeps the fisherman and deck-hand at sea through the winter; it holds the miner in his darkness, and nails the countryman to his log cabin and to his lonely home through all the months of snow; it protects us from invasion of the desert and the frozen zone. It dooms us to fight out the battle of life upon the lines of our nature or by early choice; or make the best of the pursuit which disagrees, because there is no other for which we are fitted, and it is too late to begin again."

You see, then, how this principle of habit keeps those under different social conditions fairly well satisfied. I have seen the miner lying full length on the ground, the water dripping over him from the surface veins above, and in this cold and wet condition digging with his pickaxe, the coal from the shallow strata, working not less than fourteen hours a day for the mere pittance of eight cents an hour. That same man could have changed his occupation, become an apprentice to a machinist in the large shops of a neighboring city, worked fewer hours, and received much greater remuneration. But no, this he would not do, hough he realized that his work was arduous and that it was dually making such great demands upon his vital energy that *ust needs* be shortened thereby, yet he persisted in following the same line of work, the same old occupation, at greater inconvenience and discomfort simply because he had done so for so long a time. Through the principles of habit, certain impressions had become registered upon his organism in an indelible manner and in such a way as to conspire toward making a miner's life his only natural atmosphere.

I know an old man who for twenty years had been what is known to railroad men as the "night caller," his work being to simply call those engineers and firemen who were obliged to run the night trains. Reaching an advanced age, after such a long term of faithful service, the railroad official to whom he was responsible and under whose direction he worked, decided to give him more pleasant, and what he thought more congenial employment; instead of being compelled to work the entire night, walking through the streets, exposed to all sorts of weather, he was offered a position which would pay him a little better salary and at the same time exact shorter hours of labor, and, best of all, it would be in the daytime rather than at night. At first the old man signified his grateful acceptance, entered upon the new work with all the vigor he could command, and with complete success so far as the requirements of the position were concerned. After a few days he became dissatisfied with this new and better position, and this dissatisfaction grew upon him so that in a short time he came to the railroad official and begged that he might be permitted to go back to his old-time night work even at a less salary than he was then receiving. That is, he was desirous of exchanging what ordinarily would be termed comfort for discomfort, simply because he had worked so long at night that he could not feel at home in any other environment—his world of thought and activity all centered in that employment in which he had been engaged so long. He had learned to sleep better in the daytime than at night, his food did him more good seemingly when eaten at night than the meals of which he partook in the daytime, and so his whole scheme of life had become the reverse of that which has always been followed by the majority of men.

Military men tell us of riderless cavalry horses which at many a battle have been seen to come together and go through their customary evolutions, at the sound of the bugle call. The same thing is shown in the case of many other animals. Most domestic beasts become machines pure and simple. A few years ago in a railroad accident in Ohio, the train bearing a portion of a large traveling menagerie was wrecked. The cages containing the tiger and leopard were broken open. The tiger at first emerged from the cage, and the people were awe-stricken to think of such a vicious animal being free to roam at will in the woods. But presently it was seen to creep back again to the cage; bewildered by its new environment, the tiger sought refuge in a condition of things as nearly as possible like that to which it had become accustomed after so many years of close confinement, and could not be forced from the cage to stay.

Men who have grown old in prison have asked to be readmitted after having served their time, and on this simple request being denied, they would commit some crime that would involve their incarceration in the prison again. People like to do things as they have always done them—like to live as they have always lived. In other words, the same habits of thought, of activity and of life, have become fixed and permanent. For this reason it is more difficult to elicit the interest of older persons in a new enterprise, than it is to gain the enthusiastic support of those who are younger. Habit makes people conservative, and a conservative man shrinks from new responsibilities and new relations. This accounts for the fact that most of the revolutions of the world have been wrought by young men; but on the other hand, this very conservatism is the salvation of our social institutions, so that the function of the teacher is made plain, namely, to inculcate those habits of thought, activity and life that will redound to the best interests of the individual himself, as well as of the state in which he is a citizen, and at the same time, promote the highest interests of society in which he is a member.

These habits are formed very early in life, and become so registered on the body that they are overcome only with the *greatest difficulty*. Even at the early age of twenty-five it is not a difficult matter to tell the young clergyman from the commercial traveler, or the young doctor from the young lawyer. The professional mannerisms have already fastened their hold, and one cannot escape them. His chosen profession then becomes the easiest line for him to follow, and contributes a large share towards his remaining in the position he has once chosen.

Were it not for the force of habit there would be too much changing of vocation and society would become disorganized into a seething chaos. The law of habit, though an invisible law, is as strong and inexorable as any of the laws of nature. As the law of gravitation keeps each planet within its own clear and well defined orbit, so man is kept in his proper course throughout all his activities by the law of habit. The great thing, then, in all education is to see to it that the habits of the child are of the right kind. This is the same as saying that it is the duty of every teacher to see to it that every child makes his organism, his body, his nervous system, his ally instead of his enemy. One of the greatest teachers in the Roman Catholic church caught this idea when he said, "Give me the first seven years of a child's life and I can tell you what manner of man he will become." If the pupil be kept faithfully at work a certain number of hours of each day in perfecting the development of his mind and the growth of his body, no one need have any fear as to the final result that awaits him. Mere intention is not enough of a basis upon which to judge of one's character. We judge of character by one's actions. We tell what a man is by what he does, just as we tell what any object in nature is by its qualities. Character is abiding choice. It is made up of certain converging lines of activity that have become so deeply engraved upon our organism, that tendencies to act in certain directions when appropriate occasions arise, have become established. Mere emotional enthusiasm does not count; action, and action only, is the standard by which we form our estimate of individuals.

Once while in London on a very cold and bleak February day (one of those dreariest of days which only London can furnish), as I was walking hurriedly through the streets I noticed a coachman poorly clad, shivering in his seat, waiting in front of a building quite unique, namely, a Cat Hospital. The lady whose servant he was, had found a stray cat on the street and had this coachman drive two miles through the blustering winter's day, poorly clad and shivering with cold, in order that she might give this homeless cat a comfortable place. The comfort of the cat was prized more highly than that of her servant. You excuse her by saying that she meant well—that her intentions were good. The same might be said of those persons who are quick to weep over the fictitious personages in the play of a melodrama, while at the same time real persons are allowed to go unclothed, unfed and unsheltered. This same thing shows itself in certain habits of philanthropy. One man will give to charity only when he can become a patron of the charity ball, paying a fabulous price for a box, and in no other way can he be induced to help the suffering of the lower classes of society. Another individual refrains instinctively (which means habitually) from any such ostentation, not letting his right hand know what his left hand doeth, for some giving is actually "left-handed," *i. e.*, not controlled by the same side of the brain as are the other activities.

You have seen people who are merely bundles of emotion, who, instead of being guided by habits of thought are subject only to habits of feeling. The chief element in their makeup is what may be styled, and is commonly known as "sentimental gush." Everything that such a one does, is done from emotional springs of action rather than as the result of cool, clear intellectual choice. I am reminded in this connection of a little story which well illustrates the point under consideration. Shortly after the war, an Illinois man thought he would build a river steamer from what remained of the several war ships that were used on the Mississippi river during the Civil War, by rebuilding them so as to be used as freight vessels along this great channel of navigation. He took the hull of one vessel, the boiler from another, engines from another, and his various other equipment from still other vessels. After this conglomeration was ten together, the various parts being arranged in order, and the reconstructed ship was ready to be launched, he invited a party of friends to accompany him on this vessel when it made its first trip. The vessel was gaily decorated and all was auspicious for a delightful run to New Orleans. The vessel started, a full head of steam was on, all was going well when it met another vessel coming up stream. It was decided to salute the approaching vessel by an appropriate blast of the whistle, but on this being done the engines stopped, for *it took all the steam to blow the whistle.* So it is with some people. All of their energy and vitality goes to feed a certain emotional enthusiasm which profits no one, unless coupled with intellectual choice. Now the function of the teacher is primarily the training of the habits of the mind. In thus training the habits of the individual he has before his mind as its highest aim, the completed, rounded out development of the child. Intellect, sensibility and will should each have its due share of attention from the teacher, and this done, the child cannot help but be a force for good in the state and in society. "Nothing succeeds like success" and nothing contributes so much to success as well organized habits, and for the reasons named at the outset, that habitual actions are performed with less effort, are less fatiguing, demand less conscious attention, take less time, and result in more precise forms of activity than any other that are performed. How essential then it is that seasoned, well-trained habits be inculcated, so that the development of the child may proceed without hinderance toward the true goal—the prefected manhood.

Education cannot create anything new; it can only develop and unfold the already existing faculties of the human mind. Do you not see that this great end is best achieved by the aid of one of education's most helpful servants—*habits?* The foundation of these habits transforms activities originally performed with great slowness and effort, thereby entailing much fatigue, into skillful, facile, and dextrous actions.

Children cannot be taught by maxims, precepts and proverbs. These are continually eluding memory's grasp. How admirably that old philosopher, John Locke, puts the matter when he says:

"As the years advance, they bring greater freedom from restraint, and the boy must often be left to his own guidance, because no mentor can be ever at his side except the one created in his own mind by sound principles and steady habits. It is true this is the best and safest one, and therefore worthy of the highest consideration; *for we must expect nothing from precautionary maxims and good precepts,* though they be deeply impressed on the mind, *beyond the point at which practice has changed them to firm habits.*"

The words of Niemeyer are equally pertinent: "The familiarizing of young people, even from their earliest years, with habits of order, cleanliness, decency, and politeness, will not be without lasting effects upon their inner life. Children take their first steps toward civilization in these matters. The love for regularity is thus formed. Evil habits are forgotten by disuse. The more rarely evil traits have an opportunity of appearing, the more the causes are removed by which they are excited, the more they will lose in strength just as physical powers relax when not exercised."

I think it is plain to all of us, that the best thing to do is to make automatic and habitual, as early as possible, just as many useful actions as we can, guarding carefully against growing into any ways that would be harmful to our mental or moral health, as carefully as we would against the ravages of disease in its endeavor to make onslaughts upon our physical well-being. There is a great mental saving when one can relegate the details of his daily life to the domain of habit. The more we do this, the more time and energy there is saved for the mind's higher powers in carrying on the more original and complicated intellectual processes. Otherwise, it is as if the superintendent of a large factory gave his attention to little matters of detail, such as oiling a valve here, throwing on a belt there, or hauling cinders from the engine om, instead of giving his whole mind to the broader and more mprehensive matters of policy that should concern him as the 's great head. So the mind can relegate certain mat- *etail* to the lower centers, and the activities themselves may become automatic after certain great and general principles have been decided. Professor James puts it aptly when he says:

"There is no more miserable human being than one in whom nothing is habitual but indecision, and for whom the lighting of every cigar, the drinking of every cup, the time of rising and going to bed every day, and the beginning of every bit of work, are subjects of express volitional deliberation. Full half the time of such a man goes to the deciding or regretting of matters which ought to be so ingrained in him as practically not to exist for his consciousness at all. If there be such daily duties not yet ingrained in any one of my readers, let him begin this very hour to set the matter right."

The acquiring of habits saves us from a useless waste of intellectual power, which power could be devoted to the execution of higher aims and ideals. But not only does habitude *save* power—it also *strengthens* power already possessed. Just as the blacksmith gains added muscular power by the exercise of his arms in swinging the heavy sledge-hammer, or as the peasant woman learns to carry immense burdens upon her shoulders or head, so we by stubborn practice can induce a kind of habituation in the realm of our intellectual pursuits. You know how Demosthenes conquered the drawbacks of a feeble body and defective vocal organs and became a great orator. The blind, deaf mute, Laura Bridgman, reached a high grade of intelligence by ceaselessly exercising her sense of touch.

The great secret of this wonderful development lies in action. "Not by precept, though it be daily heard," says Herbert Spencer, "not by example, unless it be followed; but only through action, which is often called forth by the relative feeling, can a moral habit be formed. The more frequently the conscious will has brought the conception-process into a certain direction, and led it to a distinct action, the *less power will be needed to do it again; the more easily will man pursue the same course in his thoughts and actions.*"

Again, we should never let an exception occur until the new habit is firmly rooted and deeply grounded in our very life itself.

A continuity of training is the great means of making the nervous system our ally in our endeavor to pursue the right course. Bain hits the nail squarely when he says:

"The peculiarity of moral habits, contradistinguishing them from the intellectual acquisitions, is the presence of two hostile powers, one to be raised into the ascendant over the other. It is necessary, above all things, in such a situation never to lose a battle. Every gain on the wrong side undoes the effect of many conquests on the right. The essential precaution, therefore, is so to regulate the two opposing powers that the one may have a series of uninterrupted successes, until repetition has fortified it to such a degree as to enable it to cope with the opposition under any circumstances."

Or, as Bahnsen so admirably states the matter: "One must first learn, unmoved, looking neither to the right nor left, to walk firmly on, in the straight and narrow path, before one can begin 'to make one's self over again.' He, who every day makes a fresh resolve, is like one who, arriving at the edge of a ditch he is to leap, forever stops and returns for a fresh run. Without unbroken advance there is no such thing as accumulation of the ethical forces possible, and to make this possible, and to exercise us and habituate us in it, is the sovereign blessing of regular work. . . . The actual presence of the practical opportunity alone furnishes the fulcrum upon which the lever can rest, by means of which the moral will may multiply its strength and raise itself aloft. He, who has no solid ground to press against, will never get beyond the stage of empty gesture-making."

And finally, let us keep the faculty of effort alive by continual exercise. The carrying out of certain fixed purposes should never be interrupted. There must ever be perseverance and a continual following up of the first success, and each subsequent advantage as well, until the highest of principles are deeply and indelibly fixed and become our own acquisition through the law of habit.

LESSON XVIII.

ATTENTION.

For the purpose of illustration, let us suppose that you are reading an interesting book; you are so interested in its contents that you are unmindful of surrounding conditions. You do not hear the clock strike; you are unaware of the noisy clamor of the street; the clatter of horses' hoofs, the rumble of carriages, the rattle of carts, and tread of passers-by are all unheard by you; you do not recognize the changes that take place in the temperature of the room; you are unaware of the time as it flies by so rapidly. The chair that has seemed uncomfortable heretofore could not now be improved upon; the light that has previously seemed dim and most trying is now most satisfactory; the room that has hitherto seemed a dingy den is practically the cosiest of quarters.

You ask: What is the cause of all this? The attention of my student friend is fixed upon the book he is reading; his entire consciousness is so concentrated upon it that there is no consciousness left for other sources of sensation, which, for the time being, are of little or no interest to him. Then you see *the sensations of which we are self-conscious depend upon attention.* I have read of students (I have never met them) so engrossed in their studies that they would be utterly oblivious of surrounding circumstances, even letting the fire go out and allowing their rooms to become freezing cold without knowing it, so interested were they in their lessons. I know a banker who frequently forgets to eat his noon luncheon, he is so interested in the work of his office. "The scholar poring over a mutilated passage of ancient manuscript, to the neglect of his appetite, or the naturalist patiently observing the movements of insects or of plants, indifferent to cold and wet," each supplies another example, illustrating a high power of prolonged concentration. Carpenter tells us of the celebrated Braunschweig mathematician, Gauss, who, while engaged in one of his most profound investigations, was interrupted by a servant telling him that his wife (to whom he was most deeply attached, and who was at this time seriously ill) was very much worse. "He seemed to *hear* what was said to him, but either he did not comprehend it, or immediately forgot it and went on with his work. After some little time the servant came again to say that his wife was sinking rapidly, and begged that he come at once to her bedside, to which he replied, 'I will come presently.' Again he relapsed into his previous train of thought, entirely forgetting the intention he had expressed, most probably without having distinctly realized to himself the import either of the communication or of his answer to it. For not long after when the servant came again and assured him that his mistress was dying, and that if he did not come *immediately* he would probably not find her alive, he lifted his eyes for a moment and calmly replied: 'Tell her to wait till I come,' a message he had doubtless often before sent when pressed by his wife's request for his presence while he was similarly occupied."

What we actually perceive depends on attention. Let the logger, the artist, the weary traveler and the hunter approach the same forest and each will place a different estimate upon it, because each looks at it from a different point of view. Each sees a different forest from that perceived by any of the others. The logger calculates the number of "lumber-feet" the choice timber will produce. The artist observes the grace of trunk, the coloring of leaf, form and outline, light and shadow. The weary traveler appreciates it for its delightful shade and mossy bed. The hunter values it chiefly for the game that can be secured within it. You have no doubt heard the story of the ntucky gentlemen who regarded a beautiful grove as of little e because "neither coon nor opossum had been caught in ove for eight years." What one perceives, depends on *res of the* object to which one gives his attention. Each of the four — logger, artist, traveler, hunter — perceives a different forest from that perceived by the other, because each attends to a feature or characteristic quite different from that which occupies the mind of the other. I myself have walked a thousand times along the same path without having observed a certain little crooked tree which was pointed out just yesterday by my little four-year-old the first time he passed by.

Attention is in every sense the prime condition of all mental operations. Every form of intellectual activity includes some form of attention. Now as all mental growth is merely the result of intellectual activity and since intellectual activity involves attention, you can readily see how intimately associated are the active increase of mental powers—real mental growth—and the power of attention. Voluntary attention, which is ordinarily labelled "concentration," lies at the basis of all accurate observation, clear memory images, reasoning, feeling, in fact all mental activity. The vividness of our associated impressions is directly dependent on the amount of attention given to them the first time they were perceived. Present impressions never exert their full force in calling up associated impresssions except when they are kept before the mind by an act of attention.

We know that the same act of knowledge, whether it be in the realm of hearing or the realm of vision or of touch — no matter in what domain — the same act of knowledge may be performed with greater or less energy. I may be endeavoring to see a certain star in some well-known constellation, and desire to see it in its relation to the other stars comprising the group. I may make but little effort and am rewarded by seeing but little. In fact the amount of knowledge gained is almost directly dependent upon the amount of effort used in the endeavor to gain the item of knowledge. *Now the greater or less effort employed in the processes of knowing is called attention.* Looked at etymologically, we find that attention is first a form of the word "tension" and means the *effort* with which any one of the mental processes may be accompanied. As such an active tension of the mental powers, attention is opposed to the relaxed state of mind in which there is no conscious exertion to fix the mind on any particular object. What the teacher calls inattention (and properly too) is the listless, drowsy state as differenced from the state of spontaneous and wakeful activity.

Before the rise of attention the soul is in a sort of comatose state, allied to a state of dreamless sleep. The mind is aroused from this stupid, lethargic condition when it begins to attend to some sensational excitement. Were it not for the acts of attention, man would always lead a vegetative sort of existence He would be ever in the condition of infantine stupor and lethargy which characterizes the early days of existence. Were it not for his first act of attention, which is evoked by some sense stimuli and consequent excitation, he would ever remain as irresponsive, dumb, unfeeling and unintelligent as an oyster. He would possess no power of self-direction and would be no more than a mere rudderless bark, or a log floating here and there in an aimless way, drifting with wind and tide — the sport of the elements.

In what way does an act of attention really contribute to mental growth? My own view is that the first result is an improvement in the discriminative ability of the senses which, as has been pointed out in a previous chapter, lies at the basis of all exact comparision, accurate memory and precise reasoning. Suppose for example, you are hefting weights. You desire to tell which of two is the heavier. To do so correctly you must *attend* to what you are doing. You cannot listen to a conversation and at the same time judge between two weights with the same degree of certainty you experience when you attend to the weights and the weights only. You are listening to the strains of the violin. Two tones are produced that are only different by the slightest shade of interval. This slight difference will be unobserved unless close attention is paid to the sounds as they are produced. Suppose again, you are trying to judge the texture of cloth, or the thickness and quality of writing paper, by the sense of touch. To do even this simple thing well, you must *attend* to what you are doing or your sense discrimination will be at fault. The *immediate effect of* an act of attention is that greater force, vividness and distinctness are given to the object before the mind, because one's discriminative ability is improved thereby. Why can the ten-year-old boy tell one railroad engine from another simply by the sound of the bell, while you or I cannot? Simply because he has attended to this peculiar feature of the locomotive while you and I have not done so. How is it that the stock buyer can guess so nearly the correct weight of a beef, hog or sheep and you or I would miss it by many pounds? You say because "it is in his line." This merely means that he, in order to succeed in his business, must attend to such things, while you and I need not do so.

Just as our sensations are rendered more distinct and clear by our attending to them, so are all our other mental activities similarly affected. Note in our acts of memory. Have you not frequently thought of this — that what we actually remember depends directly upon what we attend to? Tell a story to two children. Let one of the children be seated in your lap where he can watch every expression of face, eyes and lips, catch every sound, note every change in modulation and quality of voice and perceive every significant gesture. Let the other be occupied in building block houses on the floor, or putting together a dissected map. Is it a matter of conjecture as to which child will be best able to reproduce the story — will remember the best? Why is it the old man remembers so well the incident of his early life and can remember scarcely at all what happened yesterday? Why, simply because he was more interested in his boyhood experiences — he attended to them more closely than he did to the events of yesterday.

Then our chains of reasoning, our conclusions gained by reflection, are very dependent upon our acts of attention. Take, for example, the discovery and application of that law of cause and effect in the narrow domain of individual experience. The savage sees the rifle for the first time. When it is discharged he hears the explosion and sees the antelope fall. He reasons that the *noise* of the explosion killed the antelope, because the sound was the prime object of his attention. My little four-year-old boy came to me only yesterday insisting that his shoes be polished so they would "squeak." He observed long ago that new shoes squeaked, and attributed this to the most vivid picture in his child mind—the gloss or polish of the shoe itself.

To Newton, seated in his garden smoking his pipe, the falling apple suggested the universal law of gravitation. Why? Simply because his attention was fixed upon the resemblance between the fall of the apple and the revolution of the heavenly bodies.

Likewise, in the domain of feeling an exceedingly important element is contributed by the attentive power. Take such a feeling as that of disgust—the more you attend to it and think of the provoking cause, the more intense is the feeling itself. In the higher emotions of sympathy, pity and the like, we find that the amount of attention given to the object determines the intensity and scope of our feelings of commiseration. The sensuous thrill of music is not experienced by one who is inattentive. The master painting evokes no sublime thoughts in the mind of him who does not really study the painting in connection with the ideal it represents. So it is with our bodily pleasures and pains. In times of excitement when the attention is diverted, the keen, cutting pangs of neuralgia and rheumatism are for the time being unnoticed and not perceived. It is known that soldiers wounded in battle have hardly felt any pain at the time, so excited were they by the fray. I carry an ugly scar on my body which was caused by a serious wound when about ten years of age, but which I never felt until after the excitement of the ball game was over.

Our choices or acts of will also depend largely upon the amount and direction of the attention exerted. Suppose the boy has a lesson to get and another boy invites him to go along with him to see the circus parade. Will he go or will he remain and study his lesson? That depends on which of the two possible lines of
tivity he gives most attention to in his thought about the
atter. If he dwell in thought only on the fun of seeing the cir-
s and does not permit his mind to dwell on the consequences of
glecting his task, he will go to the show. But if these condi-
reversed and he think of the humiliation a failure at his
entail, of the displeasure it will cause his parents, the

probability of getting a "black mark," etc., he will in all probability remain at his lessons, though hard it may be. So it is in reforming and helping men. You cannot change individuals by merely prohibiting certain lines of conduct. The everlasting "No" which confronts us on every hand never makes man or child one whit better. To improve and elevate man means that a new possible line of activity must be placed before him. This new object must be of a kind to interest him—to enlist his attention and thereby gain his affection. "The expulsive power of a new affection" is the law expressive of the changes that take place in men's lives. To illustrate, in a crude way, what I mean: I am standing before my class busily talking to them. While thus engaged, and oblivious of all surroundings, I feel the touch of a friend on my shoulder. I turn *from* my class *to* this friend. It is *one* act. I turn from class to friend. So in all changes. Men do not first renounce and then take up something new, but do both at once. The gospel of mere renunciation is the gospel of negation. So with your pupils, do not insist on their lopping off certain habits before entering new lines of activity and conduct. Simply show the child something he *may* do—*not* what he must not do—and make this new possible line interesting to him, *i. e.*, enlist his attention and if you do this successfully, the old objectionable habit will atrophy.

Perhaps this brief survey will indicate to us something of the important function that attention fulfills in our mental economy. The chief function of education is simply to direct the attention along proper lines and see to it that the attention sustains itself when certain of the more important and vital facts are brought up for consideration. You readily see that the great difference between the educated and the uneducated man is found in the fact that the former has great capacity for close, steady, sustained, concentrated attention. The importance of training the attention can scarcely be overestimated. When you say to your pupils, "Give me your attention," what do you really mean? You mean that you want them to stop thinking of the game of "one-old-cat" played at recess; of the examination to come at the end of the month; of the surreptitious note—indeed of everything except what you are saying, by simply allowing what you are saying to come into the clearest self-consciousness in their own minds. An inattentive mind is an absent mind. We call people who fail to attend to certain of the common affairs of daily life that so intimately concern them, "absent-minded." In the first school I taught there was a very observant little boy, whose seat was near a window. I remember one day when asking the primary class, of which he was a member, to name all the various kinds of flowers they had ever seen; several were named, when up went little Walter's hand with a vigorous eagerness that seemed quite unusual. I gave him a nod of permission to speak, thinking he would add his contribution to the list of flowers already named by his fellow pupils. But no! He broke out with the explosive remark, "Oh, Teacher! there's ten or forty pids (pigs) in the school yard!" Little good did the crude lesson on flowers do him. He was not attending to the matter under consideration. His mind was "absent" so far as the lesson of the class was concerned.

You may have discovered in your own experience that there are two kinds of attention, just as we show later that there are two kinds of memory. I will illustrate what I mean. You are reading a rather dry, uninteresting book. You find it "up-hill" work. You hear a foot-step on the pavement below. You are tempted to look out of the window, and do so, to see who is passing by. It is only by a supreme effort that you get your mind back to your reading. Or you are in church; the sermon may not be very interesting, at least not so interesting as the bonnet or cloak worn by your neighbor. Your mind wanders from this to that object, and finally you find yourself thinking of something quite remote from the services going on in your bodily presence. Only by direct act of will can you focus your attention upon the sermon.

This leads us to name the two kinds of attention, voluntary and non-voluntary. In holding our attention down to the one *thing—the* book or sermon—in spite of its effort to wander here and there, in the effort to so focus our mental power, we are performing an act of *voluntary* attention. But when the mind wanders here, there and yonder, flitting from object to object like a restless bird, without any direction or conscious effort on our part, we have *non-voluntary* attention. It is the mere force of the object that holds the mind in the latter case, while in the former, we attend to a thing in obedience to our wish to know about it, and by an effort of will we direct our mind to investigate the fact that is consciously sought out. Or, to put it more clearly: In *non-voluntary* attention there is but *one* thing that influences the mind—the thing attended to; in *voluntary* attention there are *two* things—the thing attended to and some reason, motive or desire for attending to it. Voluntary attention may be distinguished by the presence of an aim or purpose. We attend voluntarily when we are desirous of gaining some pleasure, information, knowledge, or some real or imagined benefit from the object or thought which presents itself.

Some of us saw the great and terrible conflagration at the World's Fair Grounds last summer. I refer to the fire which destroyed the Cold Storage building in which nineteen brave men lost their lives. The ten thousand of us who stood helplessly by, as the men leaped from the lofty tower into the blazing furnace of fire, could not help but attend to the horrible sight. The eyes of every observer were riveted in morbid curiosity on the burning building and the bits of humanity leaping through the air to instant death, wondering what would next take place. One could scarcely turn from the horrible scene if he would. This close, steady observation of the burning building, while the person himself is utterly unmindful of the fact that he is standing up to his knees in water, can be styled an act of non-voluntary attention. But suppose there is a banker's clerk in the crowd who realizes that he must get his books and papers back to the bank before three o'clock or lose his position. Remembering this and turning reluctantly away—tearing himself away by sheer force from the terrible but fascinating scene—he indulges in an act of voluntary attention.

Very young children are, of course, incapable of voluntary attention. The least degree of observation will quite readily confirm this. In the very first days there is scarcely any attention of any kind. The intellectual life of the new-born child consists of a maze of confused sensations which gradually break into clear consciousness, shading through non-voluntary attention and the various degrees of voluntary attention, until the individual can of himself direct his own mind in its activities and search for knowledge.

This leads me to speak of a related fact, namely, that the stimulus to an act of attention may be either something external—connected with the object attended to—or something internal. An external stimulus consists of some interesting feature or striking characteristic of the object itself by means of which the attention is attracted and arrested. For example, the child's attention is aroused by the brilliant yellow of the orange, the tinkle of the bell, or the "cuckoo" of the clock. An internal stimulus, as you already surmise, is a motive or impulse in the mind, which motive or impulse prompts the child to put forth its attention in a particular direction, such as the desire of a child to please his teacher, or to gain a "head mark," or stand well in his class, or to bat out a "liner" every time he plays ball. Under these two sorts of stimuli—the external and internal—the child's power of attention develops with wonderful rapidity.

As long as the child is capable of non-voluntary attention only, he is at the mercy of mere outer impressions—the effects of external stimuli upon his sensorium. "As the course of a stream depends upon the slope of the ground, so the direction of his attention depends upon the attractiveness of his sensations."

But one cannot go far in the exercise of the non-voluntary attention without developing the power to attend voluntarily. Every act of non-voluntary attention on the part of the child makes every act of voluntary attention easier. In his acts of non-volunt[illegible] attention he is storing up memory images of impressio[illegible] and painful. This leads him to seek out those im-[illegible] give him pleasure and delight, and so voluntary attention begins. These first acts of voluntary attention may take place almost any time after the child is a month old.

Now in the next place, the underlying presupposition of modern Psychology, that all mental processes have a physical basis, requires us to examine the processes of attention with a view to discover their physiological correlate or "nervous" substrate. That there is such a substrate is quite apparent in many forms of attention. With reference to nearly all the data coming through the active senses—touch with movement, vision, etc.—it is evident that the muscular apparatus of the particular organ engaged—*e. g.*, the hand or eye—is clearly brought into action. To attend to any visible object, for example, a pyrotechnic display of sky rockets, fiery serpents, Roman candles, pin-wheels and the like, is to direct the eye to it by appropriate coördination of its muscles and accommodation of the lens. Certain muscles are thus innervated and produce movements as the concomitant of a simple act of attention. While this is going on, certain other muscles are inhibited from acting. Close attention, of necessity, involves arrest of movement, as is seen in the cessation of locomotion, the arrest of respiration and the modification of the secretions during an intense effort of thought.

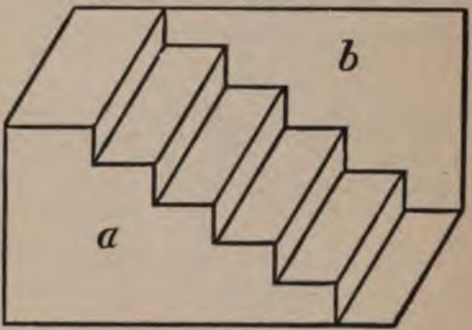

FIGURE 39.

By an act of will attention may be intensified and accomodated to the object, with a marked influence upon the quickness and accuracy of the mental processes. Voluntary increase of attention diminishes the time rate of mental processes, while dispersed or distracted attention increases it. These two changes in the clear*ness of our perceptions* take place in dependence upon the changes in the amount of attention. This is verified in our commonest experiences. On awaking gradually from sleep our surroundings become less and less obscure to our various senses as the degree of voluntary attention progressively rises. The voluntary at*tention of the* individual will oftentimes dissolve an illusion of

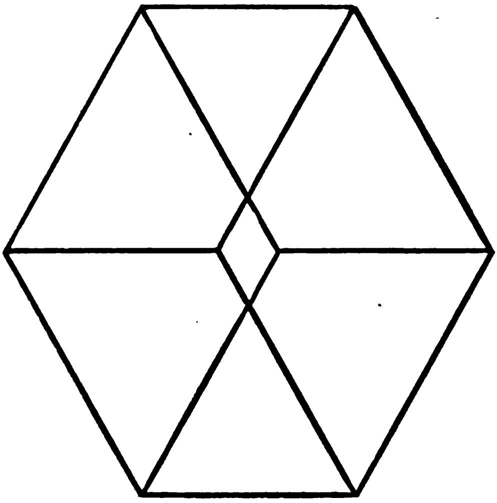

FIGURE 40.

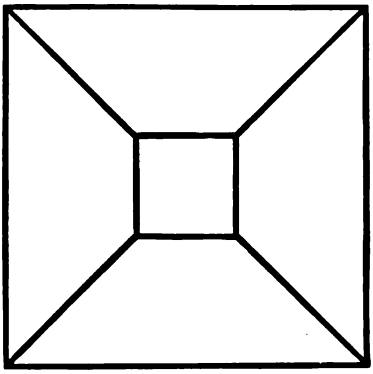

FIGURE 41.

sense and can change the entire appearance of the visual object. For example, in Fig. 39, the same arrangement of lines may be seen entire, as a staircase or a portion of an overhanging wall, *i. e.*, the point *a* in the figure can be made to appear either nearer or farther off than *b*.

So in figures 40 and 41 we can see the system of lines in either of several ways, according as we direct the attention; thus Fig. 40 may be perceived as a hollow cube opening on any of its sides. We can see it just as we desire to see it, by directing our attention to this or that feature making it especially prominent. Likewise Fig. 41 can be made to recede or stand out in relief.

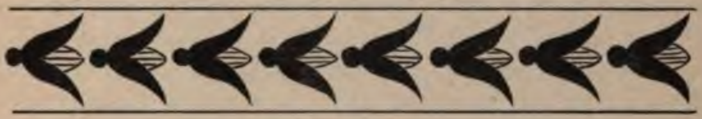

FIGURE 42.

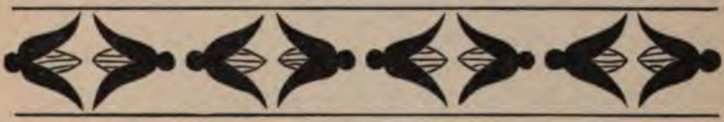

FIGURE 43.

In Fig. 42 there is a series of similar objects so arranged that certain characteristics are emphasized, thus claiming the attention, and the entire figure or series suggests motion.

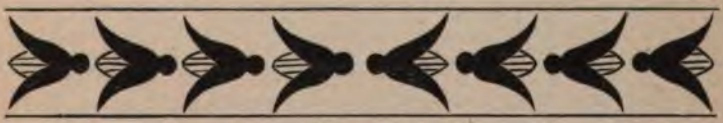

FIGURE 44.

In the second series (Fig. 43) the same figures are used, but so arranged as to intensify certain points other than those brought out in the first series — and the entire series suggests rest.

In Fig. 44 we have the same objects arranged in a still different order, and the attention is called to certain special features in the arrangement so that the entire figure suggests opposite motion.

The skillful etcher takes advantage of us and causes us to see *what is not but ought to be*, in the image thrown on the retinal mosaic. He furnishes us with a few crude lines and the mind supplies the rest. When a young child in the primary school, I had some difficulty in spelling the word "together." My teacher called my attention to the fact that it could be separated into three little words, "to" "get" "her," so the word stuck to me in the form of that rather forced set of associations, and I cannot rid myself of it. So in waiting for a footstep the anxious mother strains her attention, and the slightest noise is for the instant interpreted as the sound she so longs to hear. The track athlete, waiting for the discharge of the pistol (the signal as he starts in the hundred-yard dash), will construe almost any noise to be the chosen signal. He will make many a "false start" at the snap of a finger, the click of the pistol hammer, or the crackle of a broken stick. Why? Because his attention is so heightened that every muscle is tense, and the object thought of — the quickest possible run — tends to realize itself in movement at once. Prof. James instances the case of the meaningless French words, "*pas de lieu Rhône que nous.*" Who can recognize immediately the English, "paddle your own canoe?" But who that has once noticed the identity can escape having it arrest his attention again and again? You have no doubt heard the tale of the maiden lady, rather ancient and experienced, but none the less ambitious and aspiring (at the same time quite sensitive), who attended a religious meeting where the song "Put your armor on, my boys," was sung. As soon as the hymn was announced she jumped up from her seat and rushed from the room, relating afterward that she would not go to such a "horrid" meeting again, for they sang, "Put your arm around m[illegible]

[illegible] her example, a simple diagram like that shown in Fig. [illegible] it sometimes as two large, superimposed triangles, again as a hexagon, with angles spanning its sides, and sometimes

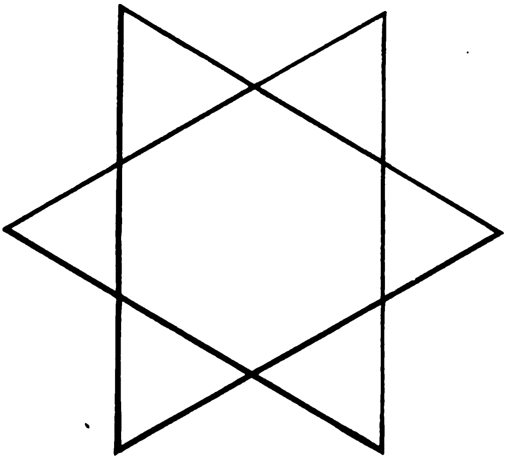

FIGURE 45.

as six small triangles stuck together at their corners. The inside of a common pasteboard mask or "false-face," when painted like the

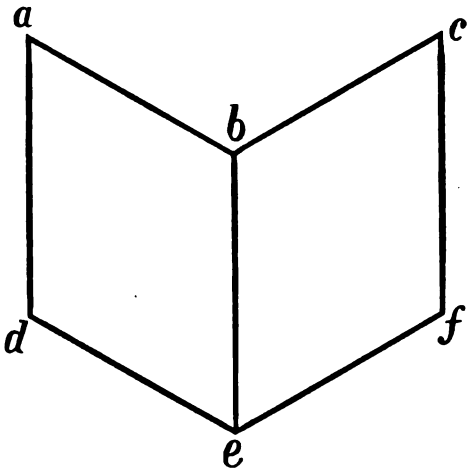

FIGURE 46.

outside and looked at with one eye in direct light, looks convex instead of hollow. Or bend an ordinary visiting card across the middle so that its halves form an angle of about 90°; set it upright on the table as in Fig. 46, and look at it steadily with one eye. You can make it appear to open towards you or away from you—can make it seem concave or convex, almost at will.

Also in Fig. 47, the ordinary representation of a scroll or rolled sheet of paper, one can make either the right or left half seem concave or convex at will. When the right half appears convex the left appears concave, and *vice versa*.

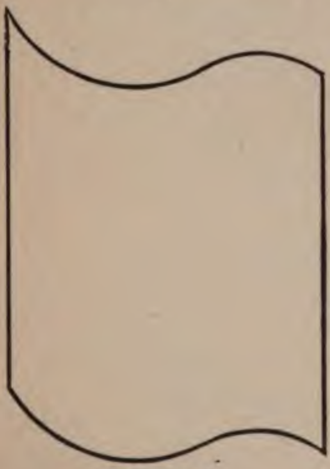

FIGURE 47.

A two-colored painting or drawing appears quite different according as a person comprehends the one or the other color as the background. The perplexing and tantalizing pictures which sometimes appear as grotesque forms and dancing sprites among the branches of the trees, especially when looked at against the clear sky, do so very readily if one conceives the bright sky as the object and the dark branches as the background of the picture.

So you can make wall-paper patterns assume many fantastic and grotesque shapes at will. Individuals have eyes for what they wish to see—ears for what they yearn to hear, and so on throughout all the sense and thought domain.

But it may also be said that voluntary attention, since it is in all probability correlated with the activity of the highest, latest developed, most sensitive, and most easily deranged nerve-cen- s, offers an excellent and important means of estimating men- ealth, growth and vigor. [In a subsequent chapter we supply ies of specific tests that are well calculated to determine these s.] Mental disease is commonly attended with disturbances of the normal process of attention. When a man is unable to throw off the cares of business and ceases to give a normal proportion of his attention to other interests, we have the manifestation of an incipient tendency to morbidness of the mental functions.

Now on what does the amount or degree of attention depend? The amount of attention exerted in any mental act depends on two chief conditions: (*a*) the quantity of nervous energy disposable at the time; (*b*) the strength of the stimulus whose function it is to rouse the attention. The first condition is directly dependent upon the state of bodily health, the amount and kind of nourishment the person receives, the time of day, etc. Thus, a healthy, vigorous child, in the early hours of the day has a surplus of energy which manifests itself in an exaggerated degree of attention to the smallest, and ordinarily most unattractive, of objects. On the other hand, a tired, weak, poorly-nourished child requires a more potent stimulus to arouse him into mental activity.

The nature of the process of attention has been considerably cleared up by recent experiments. For a long time it has been disputed as to how many impressions can be attended to at once. Of course, in a general way it must be remembered that the number of things to which we can attend is altogether indefinite, depending on the power of the individual intellect and also on what the things are. The old-time philosophers maintained that the "unity of the soul" precluded the presence of more than one objective fact or thought at the time. This artificial view was given to us in childhood by our teachers, who said it was absolutely impossible to do two things at once—a dictum, the falsity of which was demonstrated by the boys at recess, who would "rattle the bones" with the hand and at the same time sing a song of a very different measure. I once saw a "freak" on exhibition at a State Fair, who could write a selection of German poetry with his right hand and at the same time write a prose selection with his left—not letting his "left hand know what the right hand doeth." M. Paulhan has experimented quite extensively on the matter of divided attention by declaiming one poem aloud while he repeated a different one mentally, or by writing one sentence while uttering another, or by calculating certain sums on paper while reciting poetry. Paulhan compared the time occupied by any two operations done simultaneously and separately, and found that there was a considerable gain of time when done simultaneously. He himself says: "I write the first four verses of Athalie whilst reciting eleven of Musset. The whole performance occupies 40 seconds. But reciting alone takes 22 and writing alone takes 31, so that there is a difference of 13 seconds in favor of the simultaneous operations. . . . I multiply 421,312,212 by 2; the operation takes 6 seconds; the recitation of four verses also takes 6 seconds. But the two operations done at once take only 6 seconds, so that there is no loss of time from combining them."

Recent experiments show that when a number of small objects, as lines or letters, are placed sufficiently close together to be seen simultaneously, and presented to the eye just long enough for the excitation of the retina (about $\frac{1}{100}$ of a second), four, five, or even six objects can be grasped simultaneously by the attention. Professor Jevons, by counting instantaneously beans thrown into a box, found that the number 6 was guessed correctly 120 times out of 147; 5 correctly 102 times out of 107; 4 and 3 always right. Professor Cattell made a similar series of experiments in a more thorough-going and precise way. Cards were ruled with short lines, varying in number from four to fifteen, and exposed to the eye for $\frac{1}{100}$ of a second. When the number of lines exposed was but four or five, as a rule no mistakes were made. For higher numbers the tendency was to under rather than over estimate. Similar experiments tried with letters and figures gave the same result. I have often found the same thing in a much cruder experiment. When asking a class to glance just for an instant at a chandelier, they would never fail to perceive the exact number of gas jets composing the chandelier, when there were six or less in number. My lecture room is partitioned on the one side by a series of glass window panes and oak panels. There are thirty-five of these panes of glass, but on asking my students after a momentary glance, the estimate was from 25 to 32.

In the case of such related objects, of course more than one can be attended to at the same time. In the less automatic processes not more than one ought be attended to at once, for it cannot be done advantageously, in spite of the fact that Julius Cæsar is said to have dictated four letters while he himself wrote a fifth, for in the more complicated mental acts there must of necessity be a great deal of oscillation from one object to another, and consequently no gain of time.

We now come to consider the relation of interest to attention. We know that a prolonged monotonous impression fails to hold the attention. The constant whirl of the mill's machinery soon ceases to be heard by the one who works in the mill or lives near it. Such a prolonged monotonous impression has little or no effect, because it soon loses its novelty and ceases to enlist the attention. Every teacher knows that if he frequently or continually addresses his pupils in loud tones, he misses the advantage of occasionally raising his voice. I noticed quite frequently, when visiting the *Volksschule* in Germany, that they were noisier than our own schools simply because the teacher habitually spoke in the tone used to command a brigade of soldiers; and I also noticed that the children paid no heed to ordinary suggestions, but each desire of the teacher had to be expressed in the form of a command, and the child did not seem to think he was expected to obey unless the teacher came upon him like an avalanche.

We know that a sudden change of impressions, such as is produced by the unexpected firing of a gun, the flash of lightning, or brilliant flowers growing from cold, gray granite on the mountain side, acts as a powerful excitant on the attentive powers. Novelty plays an important part with reference to our acts of attention. The enterprising merchant realizes this when he prints his advertisement in "flaming colors," or heads it with startling expressions. Something new attracts the attention because it stands in contrast to our ordinary run of experience. The child, like ourselves, will attend only to what interests him. This feeling of interest (which attracts and holds the attention) may arise in various ways.

(1) Interest is aroused when the object itself or the thought presented is beautiful or attractive, *i. e.*, gives pleasure in the very act of attending to it. Thus the babe will keep his eyes fixed for a considerable time on a bright ball, or will listen attentively to a bell, because of the pleasurable effect produced. Whoever heard of a boy going to sleep at a circus? The same boy who stares into vacancy when the teacher holds forth on "common fractions" will be all eyes and ears when attending a "Christmas Tree" entertainment. The boy who can scarcely be induced to carry an armful of wood or bucket of coal for his mother, gets up before daylight to get an opportunity to carry water for the elephant of the traveling show. Pleasure is really the mainspring of nearly all our actions.

(2) Another productive source of interest is the connection or relation that the thing under consideration bears to previous pleasant or painful experiences. The child who cannot subtract 17 from 31 in the abstract, can do so readily if you ask him to perform the operation with reference to something concrete, for example, marbles. The thought of a game of marbles lends interest to the usually dry and tedious lesson in arithmetic. A child will always listen to whatever is related to its own familiar pleasures and amusements. Likewise, the attention is immediately enlisted in all those acts that are connected with the child's painful experiences. States of fear, suffering and pain are emphatically items of his experience and all ideas that can be conceived as associates with them, immediately elicit the most profound interest. The child will listen to a pitiful tale of a boy lost in the woods, pursued by bears, etc., until your story makes him weep. But
spite of the pain the story gives him, he insists on having it
d over and over again. Every painful and pleasurable experi-
e that comes to the child serves to rivet his attention upon
deas, thoughts and objects in any way related to that experi-
d gives birth to what is known in practical life as interest.
terest of the more intellectual sort arises out of what is

commonly termed curiosity. The child's attention is attracted by what is new, strange and mysterious. If he see a full-grown cucumber in a bottle whose opening at the neck is but a quarter of an inch in diameter, he at once is curious to know how it ever got in the bottle. If he see a light extinguished when lowered into a jar of carbonic dioxide, he wants to know the cause. This makes it incumbent upon the teacher to lay the facts to be acquired by the child, before him in such a way that he may discover some of them for himself. That is, do not *tell* the child everything, but let his curiosity be aroused, his interest elicited, and he will discover certain new facts for himself, and they will *stick* to him better than all you could tell him.

(4) Another secret of interest, perhaps its greatest and most fruitful source, is in adaptation. The sled, blocks, dolls, toy watches and games of childhood amuse the child because they are just suited to his stage of development, and make certain demands on his powers stimulating him to exercise them. The teacher, if he expects to interest the pupils, must place before them tasks that they are able to perform and lessons that they can easily comprehend, in order that their powers may be strengthened for greater achievements when there are "more worlds to conquer." So it behooves the teacher to continually study the child's mind, to learn its contents and "take stock" of its ideas. *Unless we know our pupils thoroughly we can never perfectly adapt our teaching to them.*

Again, we can help our pupils in becoming interested and maintaining their interest, thus developing their powers of concentration, if we judiciously arrange our daily programs of study and recitations. You may use your fingers in manipulating the keys of a typewriter until they are painfully tired; you may employ your eyes in reading fine print until they ache, but at the same time you may be able to walk without any sense of fatigue. In like manner certain of the intellectual powers may be engaged in the exercise of their functions until they are fatigued, while the rest remain comparatively fresh and vigorous. Now we know that change in work, either with reference to bodily or mental activities, is refreshing. This should be borne in mind in the arrangement of our programs. History and Geography both tax the memory severely. Hence neither should follow the other, and so on with other subjects. Greatest skill and painstaking care are necessary that the best order of studies may be determined.

Furthermore, no compulsion of teacher has ever succeeded in making a child's mind embrace an uninteresting subject. You cannot *make* the child concentrate his attention. The best you can do is to sway his attention by the leverage of interesting features, which may be made to appear in connection with the subject you desire to present to his mind for assimilation. Attention cannot possibly be removed from the sway of interest. It is, in a sense, unfortunate that many subjects do not disclose attractiveness on the surface, but only after they have been more closely examined and investigated.

Attention is therefore the great conditioning factor in our intellectual life. All kinds of acquisition depend, both with reference to its rapidity and the permanence of the results, on the energy of the attention brought to bear, and it is a well-authenticated fact and a proverbial statement, that one of the distinguishing characteristics of great productive intellect is an exceptional power of mental concentration. The power of intense and prolonged concentration and of resistance to all distraction, is one of the highest displays of intellectual and will force. In fact, all great intellectual achievement of necessity involves energy of will.

The importance of the power of voluntary attention in the economy of the mind's life and activity behooves us to make possible the careful development of it in the ordinary channels of education. It is certain that this is exceedingly desirable. In a later chapter we take this matter up in a more detailed manner. But we can here call attention to one or two general considerations.

(1) The aim should be to train the will to perfect concentration and control of the thoughts. The power of sustained atten*tion increases* with the ability to resist and overcome distraction.

To concentrate the mind is to fix it persistently upon an object, and so intently that all irrelevant objects are excluded.

(2) It should be the aim of educational methods to develop a sufficient diversity of intellectual interest so as to secure a flexibility and readiness of adjustment when various objects are brought under consideration. This latter capacity alone makes possible a wide culture and liberal education, which are not only ornamental and beneficial as accomplishments, but are also conducive to the best mental health.

Finally, voluntary attention, like all our voluntary acts, may be perfected in the form of habits. You remember we mentioned the point in the preceding chapter that habits contribute to the facility with which an act may be performed. The first manifestations of voluntary concentration come as a result of sheer will force and mental effort. Very soon after many such repeated will-efforts,a habit of attention makes its appearance in the form of a readiness to attend when certain conditions are present. Later on, this assumes the character of a more permanent attitude of attentiveness which marks off the true observer and student from the *riff-raff* of mankind.

LESSON XIX.

THE ASSOCIATION OF IDEAS.

If you think about anything at all, even for a moment, you find yourself immediately after, thinking about something else connected with it. Think about your childhood home and you may think of the house itself, its location, your parents, your child playmates, the old-time games of "leap-frog," "town ball," or "prisoner's base," the favorite fruit trees, the trout brook or the hill, down which like lazy Ned we used to coast upon the "fine new sled and beat the other boys." Some or all of these thoughts may follow each other in quick succession. Think of Chicago and you may think of the World's Fair, of how tired you became while sight-seeing, of Midway Plaisance, of Cairo Street, the Ferris wheel, and this, because of its massiveness and representation of engineering skill, may make you think of the Brooklyn Bridge, and then of the man who committed suicide by jumping from the bridge to the East River below. Thus you see, each mental event, each thought, each idea tends to *suggest* another mental event, thought or idea. Dr. Hickok expresses the whole matter in his own admirable way when he says, "The representatives of former objects of thought, when they have fallen, as it were, into memory, do not lie in this common receptacle *separately*. They are as clusters on the vine, attached one to another by some law of connection peculiar to the case, and which has its general determination for all minds, and its particular modifications for some minds. When one is called up in recollection it does not, therefore, come up singly, but brings the whole cluster along with it." This fact, namely: that thinking of anything leads us to think of something else, is called the *association of ideas.* Just a moment ago I addressed a letter to a friend.

While writing the superscription I happened to think of an addressed envelope I once saw at the Dead Letter Office. The letter was addressed to a party in "Alabama, Connecticut." Of course there is no such town in Connecticut. But the postal authorities with their far-seeing skill, acquired by long experience, decided to send the letter to *Birmingham*, Connecticut, which was done and resulted in reaching the person for whom the letter was intended. Now how did such a mistake occur? Simply because of the association of ideas which took place in the mind of the writer as he addressed the letter. In all probability when thinking of Birmingham, Connecticut, the city of the same name in Alabama (Birmingham), came to his mind, and thinking intently of the fact that there existed a Birmingham in Alabama, his hand unbidden, wrote the word "Alabama" in place of the word "Birmingham."

Now it must be remembered that there are certain rules or laws governing association of ideas just as there are laws governing any other of the mental activities. In all of its forms of functioning — be it in acts of memory, sensation, imagination, fancy or anything else — in every form of its activity, the mind acts according to certain laws of its own.

If you follow the stream of your thoughts for a single hour, you readily discover that there are very different kinds of connection or relationship between the ideas recalled and the thoughts by which they are recalled. If you think of a stream, it may impel you to think of a row you took there one moonlight night, or of the river on which you used to skate. The thought of the river makes you think of the rowing experience because when rowing you thought of the river. In other words, the thought of the river and the thought of boating *were in your mind at the same time*. On the other hand, the little white house with green shutters that I see on yonder hill makes me think of my boyhood home, not because the two houses — the house I see now and the house I remember — were ever presented to my mind at the same time, but because they are *like each other*. Again, if I were stranded on a desert isle and should see lying among the wreckage strewn along its coasts, a single piano key, I would be impelled to think of a piano, because *a part always makes one think of the whole to which it belongs.* Take still another instance. Suppose I am looking at a new piece of machinery—an achievement of engineering skill—a gigantic printing-press, for example. As I study the parts of the interesting mechanism in their relation to each other I begin to think of what it can do—how it will print, fold and paste. I stand beside the monstrous Krupp gun and I think of all the devastation and bloody work it can perform. This shows that *the perception of a cause of any kind always leads one to think of the effect it can bring about.*

Thus we might go on and to the four above classes of relations—contiguity ① in time or space, ② resemblance or similarity, ③ relation of whole to part and ④ of cause to effect—add an indefinite number. If I see in the crowd of passers-by a face that looks like the face of an absent friend, it brings that friend to mind. But just as truly objects that are unlike recall each other. This is especially true of objects that can be contrasted. Thus cold makes us think of heat, bitter makes us think of sweet, and sweet makes us think of bitter; darkness makes us think of light, and light makes us think of darkness. The various rules of association of ideas intimated above—contiguity, similarity and the like—are not sufficient because they do not account for all the facts. The list of catalogued relations which includes likeness, cause and effect, instrument and use, means and end, part and whole, must be indefinitely extended in order to explain all cases of association of ideas. Under which class of relations would you subsume the following? Mad King Lear makes an endeavor to comfort the blind Duke of Gloucester in his misfortunes; comfort suggests to him a sermon in the delivery of which, after the manner of the old-time Puritan, he holds his hat in his hand; the felt of the hat makes him think of a possible stratagem in war, namely, to shoe the horses with felt so as to come upon the enemy noiselessly. You see at once that here is a chain of associations that normally
turally arose, but which cannot be explained by mere
to certain classes of relations. Now we must have a

law more general, capable of wider application, and more far-reaching.

Now I would not for a moment have you think that the "laws of association," which are based upon classes of relations, are of no value. Quite the contrary is the case. I do think they are of much value in helping us to classify the forms or modes under which the connection between thoughts or association of ideas really takes place. For example, take the relation known as *Contiguity of Place.* If when on a railroad journey a terrible accident occurs at a certain bridge, *e. g.*, the Ashtabula wreck, I am sure ever after to think of the accident when subsequently crossing that particular bridge. In the same way associations cluster round certain localities and make them peculiarly interesting; things not at all interesting in themselves may become thoroughly interesting on account of their associations. The "Washington Elm" at Cambridge is anything but a beautiful tree, yet it is visited by thousands every year because of a certain event that transpired there over a century ago. So the field of Waterloo is visited every year by multitudes who associate with it one of the epoch-making events of modern history. We cut a cane from the Gettysburg battlefield, pick up a battered bullet on Lookout Mountain, cherish a fragment of stone from the streets of Jerusalem and bring a bottle of water from the river Jordan, because these places are associated with events of vivid interest to us. Likewise the morbid interest which leads one to carry away and cherish a blood-stained splinter from a railroad wreck, or treasure a piece of hangman's rope, can only be explained on the same ground as the associations instanced above—associations of events with things and places—they are associations of Contiguity of Place. So we might go on and illustrate any of these *so-called* laws of association—contrast, resemblance, contiguity in time, etc.; but at most they could only be regarded as principles of classification rather than as well-founded explanatory laws. At most, as laws, they are only of *secondary* value. Three, six, ten, a hundred "classes of relation" would not be sufficient to account for all the phenomena of association. Mere similarity or resemblance between objects has no causal power to carry us from one to the other. It is quite unintelligible how some writers can talk of similarity, contrast, etc., as if these mere resemblances or oppositions could be an efficient cause in the reproduction of thought processes. Besides, no such relation is ever observed until *after* the association has really taken place. These relations are effects of the association rather than causes.

In seeking to explain the large class of facts grouped under the phrase "association of ideas," it must be remembered first of all that this association or connection *is not between ideas but between things.* Ideas are not entities which can adhere, cohere or agglutinate. The Herbartian school of thinkers would have us believe that there is some inherent force in the ideas themselves by means of which one idea could attract another idea. All mental activities Herbart accounts for on the basis of the actions and reactions of *ideas.* Any such view is certainly in error.

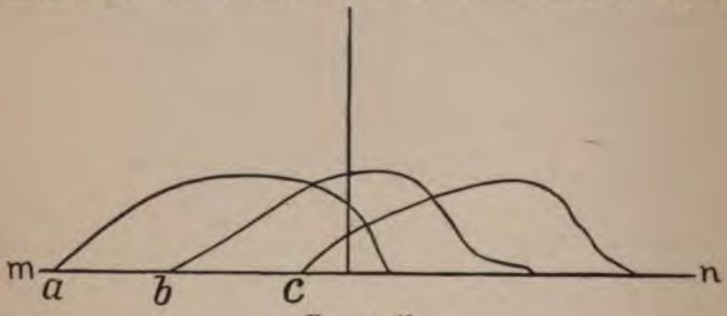

FIGURE 48.

The real principle that explains all the phenomena of association is this — *the mind tends to act again in the manner it has acted before.* Like all mental activities the process of association has a physical or cerebral basis. It is practically a cerebral law. Professor James goes so far as to say that "there is no other *elementary* causal law of association than the law of neural habit." We know with complete certainty that there is no such thing as an *isolated* mental experience or brain process. The *suc*[illegible] processes overlap each other.

Let the horizontal line *mn* in Fig. 48 represent the line of time, and let the curves beginning at *a*, *b* and *c* respectively, represent the neural processes correlated with certain thoughts or states of mind. Each process of course occupies a certain time during which its intensity changes—beginning feebly, it grows in intensity until it culminates and then it becomes weaker until it fades into nothingness. But before the process *a* has died, the process *c* has already begun, while *b* is culminating. So it is in all brain activity—one process always induces another brain process in a contiguous or connected center. This is provided for in the very structure of the cerebral cortex itself. I refer to the "association fibers" of the brain. These fibers run from one cortical center to another, connecting the different areas on the surface of the brain. These fibers run in all directions and dive down under the fissures, thereby establishing bonds of connection between areas on the cortex that would otherwise be entirely separate or isolated from one another.

Now when two elementary brain processes have been active together in previous experiences—have overlapped or acted in immediate succession—one of them recurring tends to arouse the other. But it is found in actual experience that every brain process is linked with a host of others. The question now arises which one of these secondary processes should be evoked when the elementary process recurs. How and by what is the course of association really brought about? What determines which brain process shall be aroused when the elementary process occurs again?

The course of the association is determined by no less than three factors: (1) The frequency with which each of the various processes may have acted in connection with the elementary process; (2) the strength of each of such associated processes; and (3) the presence or absence of certain possible rival processes. In the old-time text-books on Psychology the endeavor was made to account for the same thing by referring to the vividness of the original impression, to the recency of its occurrence, and to the frequency of repetition. This is the same as saying that whatever tends to fix the attention will affect the order and manner of association in re-presenting certain original impressions to consciousness. This is well and good, but hazy and indefinite. We prefer to explain the trend of association on the basis of the three cerebral or neurological conditions enumerated above. Take, for example, some of our seemingly erratic associations. I see a certain kind of bench or settee in my recitation room. A moment after I find myself thinking of Custer's massacre. By what processes I reached the thought of the bloody massacre of Gen. Custer within a half minute after I saw the settee in my recitation room, I never shall be able to conceive. Certainly the steps were not consciously taken, but they were taken nevertheless. The connection is more intimate and consequently more readily discovered in the case of the little boy who, when his father brought home a puppy, exclaimed, "Oh! Good! I aint the baby now!" Or it is even more clear and direct in this self-explanatory association which took place in the mind of my little five-year old girl just this afternoon. She was washing some little toy cups and saucers — her "doll dishes" as she called them — and before the operation was completed became rather tired of it. Finally she finished and with a sigh of relief said, "Well, I'm actually done. *Amen.*" I asked her why she said "Amen." She replied at once, "I always say amen when I finish my prayers and I guess dishwashing is just as hard as saying prayers."

You see we must refer the trend or course of the stream of associated impressions to something more elementary than mere vividness, repetition or recency of these impressions. It seems that the conditions can be none other than the neurological ones already set forth.

The physiological connection of the various cortical centers, by means of the fibers of association, is then the physical correlate or counterpart of the associated mental states. Objections are so[illegible] raised to this view on the basis that there are not [illegible] ve cells and fibers to render possible as many combi- [illegible] he nervous elements as we have ideas. We think this objection disappears when it is remembered that there probably are no less than 15,000,000 nerve-cells in every cubic inch of cortical matter, for the number of combinations possible are practically infinite. The arousement of a single impression in this very complicated network evokes, therefore, many associated impressions, some few of which are very clear, definite and strong, others less so, while many are vague, indefinite and weak. That there are varying degrees of strength of revival of impressions is a well-known fact, and one which is provided for on the basis of the theory here advanced.

The impressions that are so related and associated that they are recalled by each other, need by no means be within the realm of the same sense. In fact, the more vivid and strong associations most frequently occur between impressions of different senses, rather than between impressions of the same sense. There are as many memories possible as there are original sense impressions. The speaking of the word "apple" in my ear may evoke no less than a dozen memories or revived impressions of color, size and shape, the taste impression, the smell or flavor, the smoothness and hardness of its surface, the appearance of the word when written or printed, the muscular sensations experienced in speaking the word—all of these may be called out, of course with different degrees of vividness and clearness. Such associations must of necessity, and do readily admit of the neurological or physiological explanation. On no other basis can they be explained.

All learning or acquisition of knowledge illustrates the law of association. For example, in learning about the history of his own country or the geography of distant countries, the pupil has to depend largely upon associations of time and place in order to remember certain characteristics. In the same way he turns to account his observations gained by actual contact in his daily rounds of play. The ball he sees in the window of the novelty store is an object of intense interest to him simply because there is associated with it a host of vivid impressions of former enjoyment. Whoever heard of a boy forgetting the name of a toy or game? Why should he remember such things any better than he remembers the name of the capital of a distant state, the products of a foreign country, or a rule or formula in mathematics? Simply because the associated impressions in the primary perceptions are more vivid, clear and definite and at the same time more numerous. The point is, then, that the teacher should impress each new fact upon the mind of the pupil by means of certain, clear, well-defined, associated facts and relations. To illustrate what I mean, take this example from Lange's "*Apperception.*" "If the teacher is to explain the distance of the sun from the earth, let him ask: . . . 'If any one there in the sun fired off a cannon straight at you, what would you do?' 'Get out of the way,' would be the answer. 'No need of that,' the teacher might reply. 'You may quietly go to sleep in your room, and get up again, you may wait until your confirmation day, you may learn a trade, and grow as old as I am—*then*, only, will the cannon ball be getting near, *then*, you may jump to one side. See, so great is the sun's distance!' "

Perhaps verbal associations or word-names, whether they be names of objects, persons or places, are the most potent factors in reviving sense impressions. Indeed, the most important associations are those of words. We habitually recall our impressions by aid of verbal signs. The name of an object is, in itself, a very bundle of associated sense-impressions. While the name is a mere label of an object, by means of it alone are we able to revive the impressions that self-same object has made upon our sensorium.

But associations, to be of value, must be well selected; the more significant ones must be emphasized in our first perception so that they alone will recur with vividness. It is by no means the mark of a strong mind to be able to revive every one of the impressions originally associated in perception. The strong individual mind will select those associates that are of greatest value for his purpose and work, and these are the ones that come up in his re[illegible]tative consciousness with the greatest clearness and [illegible] those weaker minds, marked by mechanical modes of activity rather than by real individual thinking, discrimination among related impressions does not take place to any extent. All impressions seem to such an one to be of like importance, and the person is a machine grinding out the bundle of associations as originally perceived, just as a graphophone or music-box would do if properly adjusted. Those inveterate gossips who will omit no detail, however petty, in the tales they recount—those good, motherly old souls who desire to prescribe for our aches and ills, who at the same time relate how so and so was cured by the self-same remedy, giving the exact circumstances under which the cure took place, who remember dates by associating the event with the time a certain child in the neighborhood cut its teeth, and so on—these represent what I have in mind. Not long ago I read a letter written by such a person. The event related was itself of minor consequence. Yet the name of the person with whom the event was associated was given in full, his parents' names, his own exact age, the fact mentioned that he was of the same age as his cousin, that he kept a store and sold calico at so much a yard, etc. Literature abounds with just such characters. Read, for example, the utterances of that garrulous Mrs. Quickly in Shakespeare's Henry IV., or of the nurse in Romeo and Juliet; or notice the rambling words of Mrs. Tulliver in George Eliot's "Mill on the Floss." Dickens makes constant use of this characteristic in his works. The following words of Mrs. Nickleby serve as a fair illustration of what I have in mind:

[Speaking of her daughter.] "She always was clever, always, from a baby. I recollect when she was only two years and a half old, that a gentleman who used to visit very much at our house—Mr. Watkins, you know, Kate, my dear, that your poor papa went bail for, who afterwards ran away to the United States, and sent us a pair of snow-shoes with such an affectionate letter, that it made your poor, dear father cry for a week. You remember the letter? In which he said that he was very sorry he couldn't repay the fifty pounds just then, because his capital was all out at interest, and he was [illegible] [illegible] making his fortune, but that he didn't forget that you were his god-daughter, and he should take it very unkind if we didn't buy you a silver coral and put it down to his old account? Dear me, yes, my dear; how stupid you are! and spoke so affectionately of the old port wine that he used to drink a bottle and a half of every time he came. You must remember, Kate?"

Again, in answer to an inquiry about her daughter's health, she replies: "She is quite well, I'm obliged to you, my lord. Quite well. She wasn't well for some days after that day she dined here, and I can't help thinking that she caught cold in that hackney coach coming home. Hackney coaches, my lord, are such nasty things, that it's almost better to walk at any time, for although I believe a hackney coachman can be transported for life if he has a broken window, still they are so reckless that they nearly all have broken windows. I once had a swelled face for six weeks, my lord, from riding in a hackney coach. I think it was a hackney coach," said Mrs. Nickleby, reflecting, "though I'm not quite certain whether it wasn't a chariot; at all events, I know it was a dark green with a very long number beginning with a nought and ending with a nine, no—beginning with a nine and ending with a nought, that was it; and of course the stamp office people would know at once whether it was a coach or a chariot, if any inquiries were made there—however that was, there it was with a broken window and there was I for six weeks with a swelled face—I think that was the very same hackney coach that we found out afterwards had the top open all the time, and we should never even have known it, if they hadn't charged us a shilling an hour extra for having it open, which it seems is the law, or was then, and a most shameful law it appears to be. I don't understand the subject, but I should say the Corn Laws could be nothing to *that* act of Parliament."

Such illustrations as these, make it patent to the reader that our faculty of association should be selective in the exercise of its functions. The developed thinker will carefully discriminate among his impressions and the skillful teacher will emphasize in his work of instruction certain phases of the subject—in other words, certain "associates" that will be of future value to his pupil in the wisest, most economical exercise of his mental functions; for a multiplicity of paths of association may prove a hindrance rather than an aid or advantage.

Before closing the chapter, we must at least refer to the rapidity with which these associations take place in our minds. Reading is one of the best exemplifications of the activity of the associative faculty. With little practice you will find that you can name at least five hundred letters in two minutes from a printed page. In so doing we associate certain impressions of sound with certain visual impressions produced by the printed characters on the page before you. This makes *no less than four distinct acts of association in every second* that have taken place within your mind. Professor Valentin tells us that the reading of a single page of proof, containing 2,629 letters, took him two minutes and 32 seconds, which shows that he understood the import of each letter in less than $\frac{1}{28}$ of a second. These simple figures serve to indicate with what rapidity sensation calls up its associates. Professor Cattell's experiments show that the time-rate varies even among the most elementary kinds of association. For example, a word was presented, the name of a city, at the sight of which the reactor was to announce the name of the country in which it was situated; then a month was named, the reactor to tell the season to which that month belonged; the name of an author to call up the language in which he wrote, and also the name of a writer to call up one of his works. The average time for the different processes was shown to be as follows:

From city to country	0.340 seconds.
From month to season	0.399 seconds.
From author to language	0.523 seconds.
From author to work	0.596 seconds.

But this matter will be more fully discussed in our chapter on "The Time Relations of Mental Phenomena."

LESSON XX.

MEMORY.

You remember we discussed at considerable length, the sensations. They constitute the phenomena that take place in *presentative* consciousness. In the last chapter we discussed the laws and rules of our mental associations which have to do with the revival and recombination of certain original impressions of sense. These are then the phenomena of the *re-presentative* faculty, and the three phases or forms under which this faculty manifests itself are memory, imagination and fantasy. You will see in a later chapter that there are still higher and more complicated forms of mental activity known as reasoning, reflection, comparison, judgment and the like. The power which manifests itself in this highly complex manner, and through such varied processes is probably best known under the name of the *thought or rational faculty.*

In the preceding chapter on "Association," we considered the laws or conditions under which the re-presentative power manifests itself. Having done this we now proceed to apply these observations in a more specific manner. As mentioned above the three forms, phases, or modes of the mind's functioning which can be attributed to the re-presentative power are memory, imagination and fantasy. For our present purpose only the first two need to be discussed, because of their wide significance and their practical value. We shall begin with *memory.*

In our discussion of the senses we stated that all our knowledge of objects is gained through sensation. But if we were capable of only "sensing" objects we could gain no *lasting* knowledge about anything. True knowledge, even of the simplest objects, is, as you well know, not a momentary transient affair; it must be an abiding possession perduring in some form to be used at any time, whether the objects are present or not. The persistency of the various impressions which objects make upon our minds through the several avenues of sense is due to that power of mind usually called *retentiveness.* This leads us to define memory as the knowledge of a former mental state after it has already dropped out of consciousness.

The power of memory manifests itself under three distinct steps or phases: (1) retention; (2) reproduction, and (3) recognition. The second and third can be grouped together under one name—that of "recall." Since these two phases are so intimate in their relations, and so interwoven in their activities, it is no doubt better to signify both by the comprehensive name of recall. We have then the two factors, *retention* and *recall,* in every act of memory. Memory presupposes a certain exercise on the part of the senses. Memory images never arise in consciousness until after a more or less developed sense knowledge is acquired. For the first element which re-presentative knowledge involves is the revival in the mind of an image or copy of the original event. But more than the mere revival or recurrence of sense impressions must take place in order to have an act of real memory. In truth, in the mere fact of recurrence no memory is necessarily involved. In a full and complete act of memory we must have, (1) reproduction of images; (2) recognition of these images as copies of original perceptions, and (3) the assignment of such recognized images to a place in my own private history—to a place in my own past.

Memory being a form of the re-presentative power, both retention and recall are to be explained by the same laws of association that in the previous chapter were said to explain all forms of activity under which the re-presentative power manifests itself. The materials are furnished to memory according to the laws of association. The act of memory is chiefly an act of recognition. That is, in memory the individual recognizes the present image before his mind as the re-presented image of an experience in his own past. Association recalls, memory recognizes.

Your own experience will testify to the fact tha ell as retention can be explained by association in the broadest sense. Suppose you hear a familiar name, but cannot, at the moment, recall the face of the person who bears the name. One at a time you settle the points. You say he has eyes of such a color, nose of a certain shape, and so on until gradually his face appears before you, first as a cloudlike form, then becoming more clear and definite until you have a clear-cut and distinct mental picture of the person.

Mill puts the matter clearly when he says: "There is a state of mind familiar to all men in which we are said to remember. In this state it is certain we have not in the mind, the idea which we are trying to have in it. How is it then, that we proceed, in the course of our endeavor, to procure its introduction into the mind? If we have not the idea itself, we have certain ideas connected with it. We run over those ideas, one after another, in the hope that some one of them will suggest the idea we are in quest of; and if any one of them does, it is always one so connected with it as to call it up in the way of *association*. To illustrate: I meet an old acquaintance whose name I do not recall and yet wish to remember. I run over a number of names hoping that some of them may be associated with the idea of the individual. I think of all the circumstances amid which I have seen him occupied and if I chance upon any idea with which the name is associated, I then, immediately, have the recollection; if not, my pursuit of it is in vain."

Why do you sometimes tie a knot in your handkerchief or a pink string around your little finger, or change the ring to an unaccustomed finger? You answer—"To remember by." In other words, you are seeking a clear, definite and strong association by means of which you may recall a certain object.

Now, memory is not a "general" faculty—there is no memory in general any more than there is motion in general, or color in general. Just as every color is specific and definite, and every motion is motion at a given rate and in a given direction, so memory is *non-generic*. We have just as many memories as we have *kinds of* sensation-experiences. Every organ—every nerve-cell has its own memory. There is a "memory of the eye," a "memory of the ear," a "memory of the skin" (for touch, temperature, etc.), a "memory of the muscles," and so on indefinitely.

It is only in poetic figure that one can speak of objects remembered as preserved in the mind, in "memory's storehouse," in compartments, or pigeon-holes. Cicero, Plato, Schiller and others, have compared the mind, in preserving memory images, to a tablet, on which characters are impressed or engraved. Even the keen Locke indulges in such inexact language as the following: "The pictures drawn in our minds are laid in fading colors, and if not sometimes refreshed, vanish and disappear. . . . In some, it [the mind] retains characters drawn on it like marble; in others like freestone; and in others, little better than the sand. . . . We oftentimes find disease strip the mind of all its ideas, and the flames of a fever in a few days calcine all those images to dust and confusion, which seemed to be as lasting as if graved in marble." In another place, he says: "The ideas are very often aroused and tumbled out of their dark cells into open daylight by some turbulent and tempestuous passions." One of the German writers pursues the same metaphoric strain when he says: "Our present moments are as clay, our past, as chiseled marble. Then carefully mould the present, which so surely becomes the past, that memory's marble halls may contain many figures of noble design." All this is said to be very good poetry, but it is exceedingly poor Psychology.

There is, then, really no one center in the brain devoted exclusively to memory. We have no memory center on the cerebral cortex, as we have a speech center or a visual center. Each center embraces the potentialities of memory that are best adapted to the line of activity to which the center is itself devoted. Thus the seat of "memory of the eye" is in the visual center, the seat of "memory of the ear" is in the auditory center, and so on.

But memory is not equally efficient, distinct and keen in all the realms of sense. To the normal, seeing person, visual memory is the most important and significant. Of course the capacity for distinct memory images of any of the other senses is differently developed in different individuals. Charcot reports a patient who, before his illness, possessed an extraordinary visual memory. This he lost during his sickness and on recovery to health, a lively memory for sound took its place. Many people have no memory whatever for smells and tastes. When the power of writing is lost (agraphia) or in motor aphasia, the disturbance is due generally to loss of certain motor memories. For example, in the first instance, although the hand is in a normal, healthful condition, capable of executing an indefinite number of complicated movements, the power of "*recalling*" the movements which produce the letters, is lacking. Galton says, sharp sight and clear visual memory do not always go together. He has published an interesting report in his "Inquiries into Human Faculty," which report is based chiefly upon certain statistical inquiries. Among other things, he addressed a letter to hundreds of persons, asking them to describe the mental picture they possessed of their breakfast table on a given morning. The variations were many and wide.

Memory power is manifested very early in life. A child less than three months old will remember the face of parent or nurse, even for weeks. M. Perez relates the instance of a child of three months, who had been accustomed to see a bird in a cage, when it happened to see the cage without the bird, showed very marked signs of bitter disappointment. After a large number of inquiries I have discovered that the average college student remembers as far back as the third year of his age—generally some unusual event that would tend to make a vivid impression on a child's mind—*e. g.*, the death of a friend or relative, a railroad journey, or a big conflagration.

My own earliest remembered experience was that of an unsuccessful attempt, when but two and a half years of age, to drink lemonade through a straw, at the restaurant in the Capitol at Washington.

What is meant by a good memory? In passing our judgment [illegible] memory power, we must test by no less than two [illegible]—first, the readiness with which such images are recalled, and the distinctness of such images; second, the length of time the mind has retained the impression. In few individuals are these two elements equally prominent. Some have ready memory without tenacity. Others have tenacious memories without spontaneity. The memory of the young is usually more quick and ready, while that of the adult is more tenacious. Not only natural endowment, but also age, practice and education cause variations in memory power. We are told a great many stories of the prodigious memory power of the ancients. For example, it is related that Themistocles knew every citizen of Athens, and that Cyrus could recognize every soldier of his army. Hortensius could sit all day at an auction, and at evening could give an account, from memory, of everything sold, the purchasers, and the price. It is but natural that the ancients should possess better memories than we, for there was far less to divert their attention and there were fewer facts to remember. Furthermore, they never relied as we do upon writing memoranda, and the like, but retained what they desired to preserve by a pure mental act. Their method of verbal teaching also conduced to strengthen the memory. Most of us to-day, as we look back upon our university course, remember with greater clearness those facts supplied by oral lecture rather than those gained from book recitations.

The quickness with which the memory of some individuals acts is most remarkable. For example, one person hears a lot of unconnected names recited, and can repeat them all in the precise order in which they were uttered, while another can recall but few or none. One pupil can learn a page or his entire lesson simply by reading or hearing it read once; while another can, with great difficulty, repeat only a single line correctly.

As a remarkable example of a quick memory I cite the following instance, which came under my own observation. On an August afternoon in Berlin, I was walking with a friend from America who had never before been in the city. We strolled down *Friederich Strasse* toward *Unter den Linden*, conversing all the while and passing a multitude of various little shops. After going six blocks I interrupted him by saying that I must go back to Herr

Klausen's shop for some stationery which I had forgotten. My friend assured me that we had passed no such shop—that it must be further on. I was sure we had passed it, and told him so. At this, he named in order each shop which we had passed and in their correct order, just as we had passed them, as was proven by retracing our steps. He had never been on this particular street before, and yet without any serious endeavor, and absorbed in conversation, had a clear mental image of the more than eighty shops we had passed. A remarkable example of spontaneous memory is related of Adele aus der Ohe, the already famous pianist and pupil of Liszt. When *less than three years of age* she happened to be playing with her dolls in the same room in which her sister was taking her music lesson. This sister made some mistake for which she was criticised severely, and at the same time little Adele ran to the piano stool at the side of her sister and began to clamor to get upon the stool herself, calling out "*Ich! Ich!*" To satisfy her whim she was lifted to the piano and played correctly from ear memory, a large portion of the composition which the music master had himself played, and which formed the basis of the sister's music lesson.

Such a ready and spontaneous memory as here exemplified, is not really so indicative of large and profound powers of mind as it is significant as an intellectual convenience. It is the *intentional* memory that is characteristic of mental development rather than the spontaneous memory. By intentional or voluntary memory we mean those cases of recall in which the objects remembered are voluntarily sought for by a conscious mental effort. For example, as in the illustration already given, I recall the appearance of a house, the points of a landscape, the face of my friend, which at first comes up before the mind as a vague, cloud-like form, with scarcely a distinguishing point or characteristic, and seemingly without a single loose thread by means of which one might get hold of the image in more distinct outline and fill it with more definite content. Intentional or voluntary memory [illegible] henever the mind can begin with such a vague ob- [illegible] g it forth into its pristine state. In such an operation we begin with an object which we are sure in our original act of knowledge had some association with that which we seek, and we dwell upon such until the fact we seek occurs to the mind, when it is recognized and greeted with a warm welcome.

There is an intimate connection between the bodily condition and the phenomena of memory. The extent, grasp, and range of the memory span, as well as the intensity and persistence of the memory images, is dependent upon the bodily condition. By this we mean both the bodily condition at the time the original percept is acquired, and the bodily condition at the time the object is sought for in memory. Objects which are originally prehended and perceived when in a certain condition of health, when the "head is as clear as a bell," we can afterwards recall quite readily with little or no conscious effort. On the other hand, if we are wearied by labor, fatigued by tedious travel, exhausted by watching, or suffering with pain, the facts that transpire become almost a blank when we seek to recover them. This is but natural, and right in line with the deliverances of modern physiological Psychology. Since memory has its physiological expression in the power of the organism to preserve traces of impressions received and in connection with their associates, it is self-evident that the fresher and more energetic the vital and neural processes, the better may things be learned, *i. e.*, the original sense perceptions will leave behind certain deeper and more permanent traces. In this we have a reason for the fact that childhood and youth are the proper time for acquisition, and also a basis for the other fact, that what is then learned is more persistent and better preserved than the experiences of the latter years of our life. In old age we constantly find that the events of childhood are therefore remembered better, while the events of later years, though of quite recent occurrence, readily fall into oblivion.

In old age, the brain processes seem to lack the energy necessary in order to preserve fresh impressions. Thus it is that, as a class (thanks to the Fates there are some brilliant exceptions!), *old persons* revel in old f[illegible] the facts of their early days, and have little sympathy for the struggling but growing mind of the youth, chafing so impetuously at his side. Old men (as a rule) love to read old books, and young men prefer to read new books. It would be better for the world and for all concerned, if at times this condition could be reversed. As Professor James so pertinently puts it: "Our education is a ceaseless compromise between the conservative and progressive factors." We are constantly placing newly acquired facts under old heads of classification, just as we interpret and explain the new fact in light of what is already known. Thus, the child, on perceiving the *wilted* flowers in the vase, said: "Oh, mamma, those flowers are all *melted!*" The little Florida child, who called the first snowballs he ever saw, "oranges," acted according to the same inevitable law. Likewise as to the child who calls the zebra a "striped horse," or the savage who calls the horse a gigantic dog.

As we grow older we become more and more enslaved to these old stock conceptions, less capable of assimilating new facts in new ways. So it is that we have come to speak of the "dead line" of fifty, or fifty-five, or sixty years, meaning that as a rule, men do not acquire much new material beyond that age, but are simply engaged in "threshing over the old straw."

It is a general psycho-physical law that the later acquisitions of the old person are subject to more speedy dissolution than those gained earlier in life. Added to this is the fact, proven by recent investigations, that growth focuses now upon one set of organs and functions, and now upon another, which must be taken in connection with the more significant fact that the eye, hand and arm, voice, chest and other centers and functions, have certain "nascent" periods, during which they grow far more than for a long time before or after. There is, then, a certain stage in the development of the pupil when he can learn certain facts and pursue certain studies with greater facility than at any other period of his existence. By experimental investigations we seek to find out what nascent periods clearly manifest themselves at any gi[illegible] of development, and the length of time they persist. [illegible]d during these periods of maximum energy are not only acquired with greater ease but are better remembered than if acquired at any other time.

Again, things we have learned and experienced in an unusually energetic and cheerful frame of mind are more easily retained than things we have sought to acquire when petulant, enervated and out of sorts generally. This is what Spencer and other educational reformers have in mind when they tell us that the true pedagogical method will make the work of education pleasant and delightful to the child. It is a well-known fact that food is better assimilated, and hence does more good, when partaken at a meal where good cheer prevails than when one is grieved, angry, worried or anxious. So it is with our intellectual dietary. If the mental *menu* be well arranged so as to be appetizing and conducive to cheerfulness, much greater good—and a better good—will be accomplished than when one's intellectual tasks become one ceaseless, laborious grind. Indeed, the most significant of all the changes taking place in our modern school system is the endeavor to make the acquirement of knowledge pleasurable rather than painful. "Asceticism is disappearing out of education as out of life." With respect to the mental faculties and functions, it is a well-established general law that under normal conditions healthful action is pleasurable, while the forms of activity which give pain are not healthful. Children assiduously pursue those pleasures which the healthful exercise of the faculties furnishes. Experience is constantly revealing to the teacher with ever increasing clearness that there is always a pedagogical method to be found productive of intense interest and delight, and it has continually been demonstrated by other tests that any such method is the right method. It is a law of mental economy that studies are to be pursued in a manner to evoke a pleasurable interest rather than painful experiences, for only in this way can the best results be attained.

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energy and vigor in the organism, especially in the nervous centers more intimately concerned in acts of association. It is related of Sir Henry Holland, an English physician, while traveling in Germany and visiting the mines in the Hartz mountains, that *he suddenly forgot his German in consequence of over-fatigue*, and it returned to him only after he was rested and refreshed. Here are his own words: "I descended on the same day two very deep mines in the Hartz Mountains, remaining some hours underground in each. While in the second mine, and exhausted both from fatigue and inanition, I felt the utter impossibility of talking longer with the German inspector who accompanied me. Every German word and phrase deserted my recollection, and it was not until I had taken food and wine, and been some time at rest that I regained them again."

Dr. Beattie relates that one of his friends, having received a blow on the head, lost all his knowledge of Greek, although his memory was unimpaired. The same thing is noticed with regard to music. A child, having received a severe blow on the head, remained for three days unconscious. On coming to himself, he was found to have forgotten all that he had learned of music. Nothing else was lost. In seasons of extreme weakness, we cannot recover even the most familiar names, facts and dates, and our most common knowledge fails to come at our bidding. In a happy frame of mind, especially in an excited condition, memories arise which cannot possibly be evoked under ordinary circumstances. The uses of certain drugs, such as opium, hasheesh and Indian hemp, in most persons, heighten the memory power. Good, healthy circulation of the blood is an essential to a good memory.

You might be tempted to urge the fact of common observation, which seems to contradict what we have said with reference to freshness and bodily vigor, as a prerequisite of a good memory — I refer to the fact that so little is remembered of the experiences tha spire in the earliest years of childhood, when the brain nd most impressible. As already stated, memory sel- ack beyond the third year of our childhood. This is due largely to the fact that the paths of association in the "brand-new" brain of the infant, are not clearly defined, well-fixed or deep-seated, and is also due to the fact that what a child learns during the first year or two of his infancy is very different from the acquisitions of later years. There is a want of continuity and harmonious progression between the experiences of the earliest and those of the more mature years, and, as a rule, a want of that interest which is necessary to frequent recall,and persisting retention,of the older events fresh in memory.

It is not out of place for us here to notice that certain times of the day and certain seasons of the year are most favorable and especially conducive to the successful acquisition of facts for subsequent remembrance. As a rule, the later evening hours, or "wee sma' hours" permit the attention to be most intently fixed upon the object of thought; but it is sometimes found that the acquisitions of the midnight toiler, which seemed to be so clear and distinct, and bid fair to be so persistent, have well-nigh vanished in the morning. Much depends upon the individual peculiarities of the student. For myself I find that the hours from ten to two o'clock at night are the hours in which I do the best work. By this I mean that during these four hours of the twenty-four greater rapidity of thought, clearer associations and more intense concentration are possible than at any other time of the day. I would not recommend such unseasonable hours to any student, any more than I myself would listen to a recommendation from some one else to the effect that five o'clock in the morning is the time at which to take up the heavier mental tasks. This is certain, that the person who sleeps less than the rule, *e. g.*, the person who sleeps but five hours, ought by all means eat more and oftener than the average person, if he wish to sustain careful, painstaking, mental effort. Loss of sleep should always be offset by porterhouse steak, or something equally nutritious.

Both classes of facts—those which indicate t
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can be accounted for on the basis of the views we have already expressed with reference to the relation of reciprocity that obtains between body and mind. The varying condition of the body through the several sensations of which it is primarily the occasion, enters into all the experiences of consciousness, and is really the backbone of them all. It is the great screen on which all the mental activities are projected, and is the never-failing basis and accompaniment of them all. If the sensations are made abnormal, disturbed or unpleasant, owing to certain peculiar conditions of the body, the mind is so absorbed or distracted by the obtrusive and unusual elements of the sensations that it has little attention for other objects, and little or no energy to concentrate upon them so as to make them well remembered.

It is pertinent here to refer to what is ordinarily called physiological memory. It is a well-known fact that old habits are difficult to overcome, and that fatigue or carelessness will lead us unconsciously to forsake a new for an established method of action. But it is only by means of experiment that we can tell whether the old habit interferes with the forming of a new path. To decide this problem was the object of a series of experiments undertaken by Mr. Bergström at Clark University only a few months ago. Unprinted cards were made into packs of eighty, each pack containing ten kinds of cards, and each kind having the same abstract word printed at the top, such as "Vitalism," "Homophone" and "Identity."

There were, then, ten groups, of eight cards each, in each pack of eighty. The experiment consisted in sorting two packs in quick succession, placing cards containing the same word in the same pile, the arrangement of the words to be different for the second pack. The length of time required for sorting the second pack was longer in nearly every case, differing with different individuals from three to seventeen seconds. The arm, from mere habit or physiological memory, would seek to place a given card (e. g., one bearing the word "Identity") in the same relative position [illegible] nce to the other cards, as the cards bearing the [illegible] placed in sorting the first pack. The arm would do this of itself before the mind, as it were, got a chance to direct it to the new position occupied by cards of that kind when sorting the second pack. The results gained by Mr. Bergström are quite in harmony with those of previous investigators. He found that memory is closely related to habit and that habits are chiefly physiological in their basis. His results also show that men are influenced with respect to memory as well as other activities, by the state of the weather, by food, the frequency and amount of rest, and by whatever would tend to modify the regularities of mental life, as grief, anger, anxiety and melancholia.

Many have raised the question as to whether absolute forgetfulness is possible—that is, can the soul lose beyond recovery anything which it has once known? In answer to this question, it may be said that knowledge which has remained out of sight for a long period has often been suddenly recovered. Numerous examples have occurred and not a few are recorded in history. The classical tale which was originally published by Coleridge, is a case in point. It relates to a servant girl in Germany, who was very ill of a nervous fever, accompanied by violent delirium. In her excited ravings, she repeated long passages from classical and rabbinical writers, which excited the wonder, terror and superstitious dread of all who heard her, most of these persons thinking the girl to be inspired by some good or evil spirit. Some of the passages, when written down, were found to correspond with literal extracts from learned books. On examining into the history of her life, it was found that several years before, when very young, she had lived in the family of an old and learned pastor in the country, who had been in the habit of reading aloud favorite passages from the very writers in whose works these extracts were discovered. These sounds, at that early age so unintelligible and meaningless to her, were nevertheless so deeply impressed upon her mind that under the excitement and delirium of the troublous fever, they were reproduced in memory and involuntarily uttered. Numerous cases are [illegible]s that illustrate this same interesting fact. [illegible] Italian, he once attended, who died in Ne[illegible] and who, in the first stages of his illness, spoke English; at a later period, spoke only French; and just before his death, spoke only the language of his early boyhood, Italian. Dr. Mühlenberg, formerly a renowned Lutheran clergyman in Philadelphia, has made the interesting observation that old German immigrants, whom he visited during their last illness, frequently prayed in the native tongue of their fatherland, though some of them had not spoken it for fifty or sixty years. These instances conspire with others to illustrate the fact that the bodily condition and the phenomena of memory are intimately connected and vitally associated.

The memory is readily affected by any physiological disturbances in the organism—indeed, the memory is probably the faculty first to react to any disorder in the organism. How far a failure to remember can be regarded as an abnormal affair is really a matter of degree, and must be decided on the basis of the circumstances in each case. A person who can repeat the names of the rulers of England in the order, and with the dates of their accession to the throne, is said to have an unusually good memory, while the person who cannot remember the name of his street or the number of the house in which he has lived for years may certainly be said to have a poor memory. But by a good memory should be meant not only the persistence of certain conscious images, but also the ability to recall these images into consciousness when occasion demands.

In the approach of general paralysis memory always fails, especially for recent events, and the acquirement and retention of new ideas becomes progressively less. After a time there is marked absent-mindedness and a forgetfulness of the most commonplace duties; even meals are forgotten. Such a person, forgetful of what he was about to say, making mistakes in counting or changing money, becomes easily confused and is totally unfit for business.

The term *amnesia* is used to designate the pathological condition in which there is a loss of memory. We have, according to classification of Ribot, (1) Temporary Amnesia;

(2) Periodical Amnesia; (3) Progressive Amnesia, and (4) Congenital Amnesia.

Temporary amnesia usually makes its appearance suddenly and ends just as suddenly as it came. The attack may extend from a few minutes to long periods of time. The briefest but clearest and most common forms are met with in epilepsy. In the epileptic and similar attacks, there is no recollection (or at most only the slightest trace) of what has transpired.

To illustrate: "A patient while consulting with his physician is seized with epileptic vertigo. He soon recovers, but has forgotten having paid his fee a moment before the attack. An educated man, thirty-one years of age, found himself at his desk, feeling rather confused, but not otherwise ill. He remembered having ordered his dinner, but not of eating or paying for it. He returned to the dining-room, learned that he had both eaten and paid, showing no signs of being ill, and had set out for his office. Unconsciousness lasted about three quarters of an hour." Another epileptic, seized with a sudden paroxysm, fell in a shop, got up, and eluding the shopman and his friends ran away, leaving his hat and order book behind. He was discovered a quarter of a mile away, asking for his hat at all the shops, but not having recovered his senses, nor did he become conscious until he got to the railway ten minutes after. Sometimes the loss of previously known facts is so complete that re-education becomes necessary. "A clergyman of rare talent and energy, of sound education, was thrown from his carriage and received a violent concussion of the brain. For several days he remained utterly unconscious, and when restored, his intellect was observed to be in a state similar to that of a naturally intelligent child. Although in middle life he commenced his English and classical studies under tutors and was progressing satisfactorily, when, after several months' successful study, his memory gradually returned, and his mind resumed all its wonted vigor and its former wealth and polish of culture."

"A gentleman about thirty years of age, of wide learning and many acquirements, at the termination of a severe illness wa found to have lost recollection of everything, even the names of the most common objects. His health being restored, he began to re-acquire knowledge like a child. After learning the names of objects, he was taught to read, and after this, began to learn Latin. He made considerable progress, when, one day in reading his lesson with his brother, who was his teacher, he suddenly stopped and put his hand to his head. Being asked why he did so, he replied: 'I feel a peculiar sensation in my head, and now it appears to me I knew all this before.' From that time he rapidly recovered his faculties."

In many cases of memory disorder, the cause of the disorder is retro-active; that is, the period of forgetfulness extends back of the time when the real cause of the amnesic disturbance comes into existence. This can be made more clear by reference to a single illustration: A friend of mine for three years played the position of "center rush" on the foot-ball team of an eastern institution. He was for one year the captain of the team, and, of course, was responsible for all the plays made—a responsibility which every true college man glories in, and of which he desires to acquit himself in the best possible manner. During one hotly contested game, he was badly injured in the last half, becoming unconscious for a few minutes, and then delirious. Now, though he was injured in the last half of the game, in the very closing minutes, and though he had directed every play previous to the injury, he could not remember a single play of the entire game. The results of the injury, so far as memory was concerned, ex-
nded back to a period *preceding* the time at which the injury
elf actually occurred. In other words, the cause of the mem-
disturbance was retro-active in its effect upon the memory
ges that were in the mind at the time of the mishap.

of the forms of memory disorder tend toward the *de-*
the memory faculty itself. Those instanced above
ly such as show diminution or effacement of the
r. But there are cases just as morbid and patho-
are entirely opposite in character—cases in which
ctions act with increased intensity, acuteness, and

persistency. This state of exaltation of memory is called *hypermnesia* to distinguish the phenomena from those of *amnesia*. Exaltations of memory may sometimes be general, but they are more frequently partial.

There are several accounts of drowning persons saved from imminent death which go to show that at the moment of asphyxia they seem to see their entire lives unrolled, "as a scroll," before them, even to the minutest detail. One such testifies "that every instant of his former life seemed to glance across his recollection in a retrograde succession, not in mere outline, but the picture being filled with every minute and collateral feature forming a kind of panoramic picture of his entire existence, each act of it accompanied by a sense of right and wrong." Ribot relates an analogous case of "a man of remarkably clear head who was crossing a railway in the country, when an express train at full speed appeared closely approaching him. He had just time to throw himself down in the center of the road between the two lines of rails, and as the vast train passed over him, the sense of impending danger to his very existence brought vividly into his recollection every incident of his former life." Even when interpreted most liberally, such examples show a marked intensity on the part of the memory that is much above the ordinary.

Such exaltation of the memory as has already been stated, may also be induced by the use of drugs and some of the narcotics and intoxicants. A classical example of this is that of De Quincey in his "Confessions of an English Opium Eater," in which he says:

"Sometimes I seemed to have lived seventy or a hundred years in one night. . . . The minutest incidents of childhood, or forgotten scenes of later years were often revived. I could not be said to recollect them, for if I had been told them when waking, I should not have been able to acknowledge them as parts of my past experience. But placed as they were before me, in dreams like intuitions, and clothed in all their evanescent circumstances and accompanying feelings, I recognized them instantaneously."

Abercrombie, in his "Essay on Intellectual Power," tells us of a remarkable case of partial excitation which cannot be overlooked. It is of a lady who, in the last stage of a prolonged illness, was carried from London to a lodging in the country. At her request, her infant daughter was taken to visit her, and after a brief stay of but a few hours, carried back to the city. The lady died a few days after and the daughter grew up, without any recollection of her mother, until she was of mature age. It happened one day that she wandered into the room in which her mother had died without knowing it to have been so; strange to say, she started on entering it and when a friend, surprised at her agitation, asked the cause of it, she was met with the reply, "I have a distinct impression of having been in this room before, and that a lady who lay in that corner and seemed very ill, leaned over me and wept."

We add one more case by way of illustration, taken from Dr. Carpenter's rich fund of interesting examples. "A clergyman, endowed with a decidedly artistic temperament (a fact worth noting in this particular instance), went with a party of friends to a castle in Sussex, which he did not remember to have previously visited. As he approached the gateway, he became conscious of a very vivid impression of having seen it before; and he seemed to himself to see not only the gateway itself, but donkeys beneath the arch, and people on the top of it. His conviction that he must have visited the castle on some former occasion made him inquire from his mother if she could throw any light on the matter. She at once informed him that, being in that part of the country when he was about eighteen months old, she had gone over with a large party, and taken him in the pannier of a donkey; that the elders of the party, having brought lunch with them, had eaten it on the roof of the gateway where they would have been seen from below, while he had been left on the ground with the attendants and donkeys."

What has already been said goes to show the intimate relation between the phenomena of memory and the brain as the physical basis. Memory, just like association, is absolutely conditioned upon the brain-paths, and the excellence of memory depends upon the number, directness and persistency of these paths through the brain. The *number* of such brain-paths is directly dependent upon the variety, complexity and range of his "perception" experiences. The *persistence* of the paths is dependent upon the quality of the brain tissue, its plasticity, texture, development with respect to fibers of association. The quantity and quality of the blood supply, the age of the individual and a host of other factors contribute to the tenacity with which the brain retains the sense impressions and their "associates." We have already referred to the enfeeblement of memory in old age and by means of fatigue, drugs, narcotics and the like. You have seen individuals weakened by age in whom the brain-paths are not at all permanent—persons who will ask the same question over and over again, not remembering that they have asked it before or received an answer.

The number of associated precepts must be increased if memory is to be strengthened and rendered more effective. As already stated, in order to have a good memory one must form many and diverse associations with every object he perceives, each of which he may use as a clue in his later search for the object in thought. Individuals have better memories with reference to facts that lie within their own line of occupation and observation. Men tend to specification in memory. What one is continually thinking of, that he remembers best of all. The broker on 'change will remember the stock quotations; the railroad conductor will remember the names of stations, the exact distance between them and the time his train is due at each of them; the dry-goods merchant remembers prices; the policeman, the names of the streets on his beat; the hotel clerk will be able to call by name nearly all the patrons of the house; the college athlete the records of every high jump, 100-yard dash or pole vault made in the course of a year, simply because he makes a specialty of such facts and thinks over them continually, while he may not remember his lessons for a single hour, just because he does not make a specialty of his lessons or the class of facts with which they deal.

LESSON XXI.

IMAGINATION.

We have already spoken of memory as one of the forms under which the re-presentative power of the mind manifests itself. Another phase of manifestation assumed by this same re-presentative power is met with in the activities of the imagination.

In a general way, by the imagination we mean that power of the mind by means of which ideas of things not present are formed. Materials already present to the mind, whether retained, or recalled by memory, or actually present to sense-observation are recombined into new wholes. The raw materials of sense and memory are really wrought into new fabric by the power of imagination. The imagination *never creates new material but only new forms*, under which the material already possessed may appear. Thus you may imagine a tree growing from the back of an elephant, but the image thus created is made from materials already perceived by the senses. In its essential features the elephant is like elephants you have already seen, and the tree, in its main charactristics, is like trees already met with in your past experience.

This imaging power manifests itself very early in the life of each individual. The child cries for a lost but treasured toy—his rattle-box or gaily-colored ball. You substitute another toy, hoping to appease him, but he dashes it angrily to the floor be-
it does not correspond to the image he has in his mind—a
of the toy as it should appear. A boy has his mamma
letter to "Santa Claus," telling his wants and expecta-
r the Christmastide. Perhaps it is a box of tools. The
s a picture in his mind of just how that box of tools
look, the saw it is to contain is clearly before his mind's
he can almost tell the number of its teeth. The hatchet

must be painted red, and so on. This boy has *imaged* by his own mental effort, the things he has not actually seen as yet. Or perhaps it is a little girl who has prayed that good old "Kris Kingle" would bring her a beautiful doll. She has in mind the kind of a doll she desires. It must be of a certain size, with eyes that open and shut, must have hair that curls, and must be clothed in a dress that is "hem-stitched" and "herring-boned" or "feather-edged." That is, in the absence of the actual object—the doll—she has pictured to her mind just how it should look when it actually materializes—when it is no longer a figment of the imagination—the doll of her dreams—but a real "flesh and blood" doll.

There are two kinds of imagination. When the child cries for its lost toy, the act of the imagination simply consists in holding before the mind a more or less faithful copy of the toy as seen in his previous experiences. The boy comes in at the schoolroom door with a small stick in his mouth. The teacher asks him what he has in his mouth. He answers, "a cigar." He is told that smoking is not allowed in the schoolroom for he might set fire to the clothes of some of the children. He imagines the stick to be a cigar, and the teacher tactfully and properly carries out the idea. The first of these two cases illustrates the one kind of imagination, known as the *reproductive imagination.* The second case represents the second kind of imagination—the kind that is to receive more especial attention in this chapter—the *constructive imagination.*

You can readily see that the imagination and memory are very closely related to each other. In fact, in some of the phases under which it manifests itself, one cannot readily distinguish between acts of reproductive imagination and memory. Certain it is that they are most intimately associated. Unless memory restore the impressions of past experience, who could picture a new event or object? How can you imagine a new color without recalling certain colors you have already seen? Principal Russell, of the Worcester Normal School, tells us of a boy who, at the age of seven, was observed one day as he stood drinking water at a sink, with his back to other people. He was making believe that he was drinking in a saloon, and stood with his feet crossed, remarking on the quality of the drink to the imaginary barkeeper. He paid imaginary money and received imaginary change. How could this stripling of a boy construct any such piece of drama without the service rendered by his memory power?

The distinction between the reproductive and creative or constructive imagination is as old as Kant; and yet, for more than a century have psychologists labored to define the exact domain of each of these kinds of imagination. For our purpose it is sufficient to say that the reproductive imagination must furnish all the raw material—its function is to reproduce the sense-impressions. The creative or constructive imagination combines this material into an endless variety of forms, but at the same time is, to some extent, limited by this self-same material.

Now, you have already learned that children differ greatly with reference to the development of their various sense capacities. It has been made plain that no two children see, touch, hear, smell or taste alike. Each child receives a sense-picture of the outside world quite different from that received by every other child in the universe. *Perceiving things differently—receiving such different impressions*, you can see quite readily that the raw material supplied to the imagination for it to mould and fashion at will, is quite different with different individuals. This gives rise to enormous individual differences in the imagination among children. We shall first take up the differences with respect to the reproductive imagination.*

Psychologists have distinguished at least four different types of mind according as the images arising from one or the other of the four senses predominate in imagination. We have therefore, (1) the tactile type; (2) the visual type; (3) the auditory type; (4 type.

e *Type.* To this class belong those individuals

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m gives an interesting and extended summary of these differ-
ellent article in "The Pedagogical Seminary," Vol. II, No. 2,

who reproduce in the imagination, chiefly such impressions as come through the dermal senses, be these impressions within the realm of either the temperature, pressure, contact or tickle sense. This class is, I think, comparatively small in number and is made up chiefly of defectives. The blind deaf-mutes, such as marvelous Laura Bridgman or Helen Kellar, must obviously belong to this type. The celebrated "Franz" case is a good illustration of the point in question. Dr. Franz, the surgeon who so skillfully treated the young man, satisfied himself, by experiments, that the patient could not in the least discern objects by sight. "My experiments led me to the conclusion that his belief that he really saw objects resulted solely from his imagination, combined with his power of reasoning. In feeling of an object and bringing it in contact with the eyelids and the cheek, an idea of the object was produced, which was judged of and corrected according to the experience he had gained by constant practice. . . . The patient's sense of touch has attained an extraordinary degree of perfection. In order to examine an object minutely he conveyed it to his lips. . . . When made to see by the removal of the cataracts from off his eyes and shown geometric figures, he said he had not been able to form from these figures, the idea of a square and a disk *until he perceived a sensation of what he saw in the points of his fingers, as if he really touched the objects.*"

We are all able to reproduce images of previous touch sensations with more or less vividness. The dry-goods merchant is rather dependent upon the "feel" of the goods in trying to discriminate among fabrics as to the quality of their texture. The blind student in my class who writes his examination paper by means of an ingeniously constructed typewriter, in relying upon the touch of the keys, is quite largely dependent upon his tactile images. Likewise when he reads from his books in which the characters are represented by "raised letters."

At the World's Fair in my little laboratory I made a series of tests upon all visitors who were willing to submit to them, and found enormous differences with reference to the reproduction of tactile images. Of course, experience and training have everything to do with reference to the development of this capacity within us.

2. *The Visual Type.* The mass of people belong to this class. With the large majority of persons visual images predominate in their thinking. This is probably the reason that most people prize the eye above all the other senses. This you know to be actually the case. Ask your pupils which sense they prize most highly, and I think they will be quick to tell you that it is the sense of vision. This expression of popular opinion finds support in the words of Henry D. Thoreau, "the poet naturalist," who says: "The eye does the least drudgery of any of the senses. It oftenest escapes to a higher employment. The rest serve to escort and defend it. I attach some superiority, even priority, to this sense. It is the oldest servant in the soul's household. . . . If any joy or grief is to be expressed, the eye carries the news. . . . How man serves this sense more than any other!"

There are, of course, among this class—the visual type—very great individual differences, varying from the visualizing power possessed by the ordinary pupil, who can learn his lesson of a series of words easier by seeing them than by hearing them, to the prodigy among the artists who paints his portraits from ideally visualized subjects.

Professor James clearly illustrates these individual differences by two cases which are gleaned from reports made by students of his class in Psychology, in response to his inquiry as to their mental image of the morning's breakfast table. The one who is a good visualizer says: "This morning's breakfast table is both dim and bright; it is dim if I try to think of it when my eyes are open upon any object; it is perfectly clear and bright if I think of it with my eyes closed. All the objects are clear at once, yet when I confine my attention to any one object it becomes far more distinct. I have more power to recall color than any one thing; if, for example, I were to recall a plate decorated with flowers, I could reproduce in a drawing the exact tone, etc. The [illegible] anything that was on the table is perfectly vivid. There [illegible] ittle limitation to the extent of my images; I can see all four sides of a room; I can see all four sides of two, three, four, even more rooms with such distinctness that if you should ask me what was in any particular place in any one, or ask me to count the chairs, etc., I could do it without the least hesitation. The more I learn by heart the more clearly do I see images of my pages. Even before I can recite the lines I see them so that I could give them very slowly word for word, but my mind is so occupied in looking at my printed image that I have no idea of what I am saying, of the sense of it, etc. When I first found myself doing this I used to think it was because I knew the lines imperfectly; but I have convinced myself that I really do see an image. The strongest proof that such is really the fact is that I can look down the mentally seen page and see the words that commence all the lines, and from one of these words I can continue the line. I find this much easier to do if the words begin in a straight line than if there are breaks."

On the other hand, the poor visualizer says: "My ability to form mental images seems, from what I have studied of other people's images, to be defective and somewhat peculiar. The process by which I seem to remember any particular event is not by a series of distinct images, but a sort of panorama, the faintest impressions of which are perceptible through a thick fog. I cannot shut my eyes and get a distinct image of any one, although I used to be able to a few years ago, and the faculty seems to have gradually slipped away. In my most vivid dreams, where the events appear like the most real facts, I am often troubled with a dimness of sight which causes the images to appear indistinct. To come to the question of the breakfast table, there is nothing definite about it. Everything is vague. I cannot say what I see. I could not possibly count the chairs, but I happen to know that there are ten. I see nothing in detail. The chief thing is a general impression that I cannot tell exactly what I do see. The coloring is about the same, as far as I can recall it, only very much washed out. Perhaps the only color I can see distinctly is that of the table-cloth, and I could probably see the color of the wall paper if I could remember what color it was."

Fechner, in his pioneer book, *Elemente der Psychophysik*, was, in all probability, the first to call attention to these personal differences with respect to the power of visual imagination. His published accounts show great individual diversity. The work of gathering a large fund of information capable of being reduced to statistical form, anticipated by Fechner, has been admirably carried out by Francis Galton, the English psychologist, who first published his results in 1880.

Among other things Galton found that the great majority of men of science were very deficient in visualizing power. On the other hand, when he made inquiries among people met with in general society, he found quite a different state of affairs. "Many men, and a yet larger number of women, and many boys and girls, declared they habitually saw mental imagery, and that it was perfectly distinct to them and full of color. The more I pressed and cross-questioned them, the more obvious was the truth of their first assertions. They described their imagery in minute detail, and then spoke in a tone of apparent surprise at my hesitation in accepting what they said. I felt that I myself should have spoken exactly as they did, if I had been describing a scene that lay before my eyes, to a blind man who persisted in doubting the reality of vision."

It is a mistake to suppose that sharp sight and good visualizing power go together. The two faculties are quite independent of each other. Galton tells us of persons who read their addresses from *mentally* seen manuscripts. You may have had pupils who could recite their lessons when told on what page and the portion of the page the topic, concerning which your question dealt, was treated and discussed. Some persons see *mentally* in print, every word as it is uttered, and they read off the address from the imagined printed page instead of attending to the sound of the words as spoken. Galton also found the power of visualizing more highly developed in the female sex than in the male, and that it is somewhat higher in schoolboys than in men. There is strong reas port the belief that it is very high in some young guage and book-learning tend to dull this power.

Margaret Whiting in a recent article* makes an interesting confession of her own early childhood experiences with the arithmetical tables of addition and multiplication. These notions concern the individuality of numbers and began when she was about eight years of age, when arithmetic first became known as a study. Belief in these notions was held without question for at least four years. In her descriptive list she characterizes the various numerals as follows:

"1, 2, and 3 were children, 4 was a woman, a good, self-sacrificing woman, who always reminded me of Edna Kenderdine in 'A Woman's Kingdom.'

"5 was a mischievous young scamp, with animal spirits, a capacity for getting into scrapes, and luck in getting out of them.

"6 was a prince, amiable and possessed of very good manners, easily cheated by impostors, weak and dependent.

"7 was an arrant rogue, full of schemes for his own advantage, without regard to others. (A character so unscrupulous that I always considered him too bad for general society.)

"8 was a lady, high-born and haughty, gracious to the unfortunate, severe to all offenders, a musician, and in all ways accomplished; by far the most distinguished of the company.

"9 was reckless but generous, always helpful to others, always disregardful of self. He was very tall and walked so carelessly that he often stubbed his toe.

"10 was a great lord, cold and formal. He took the places assigned him as his right, was too elevated in station to help or hinder the other people.

"11 was the herald of the King. He ran before 12 and prepared the way for royalty. He was very clever, and was always busy.

"12 was the King. He was merely a majestic figure-head; and noticed only those who had climbed near the throne.

"The first move of interest in this drama of numbers was caused by 5 when he coaxed an innocent child to help him run away from home. 5 runs till he reaches 10, bu [illegible] gets there he stops to help 6. 5 cannot put 6 into 12 where he wanted to go, and so drops him next door to 12. Though good-natured, 5 is easily moved by wickedness, and so is persuaded by the designing 7 to help him instead of 6, into 12. At this, 8 is so angry that she thrusts thoughtless 5 into 13. Here he stays till kind 9 rescues him and puts him into 14. 2 helps 6 into 12, but he cannot stay, for 7 is already there and the place is not large enough to hold both. 7 is stronger than 6, and so succeeds in putting the unfortunate prince into 13, which is a mild prison. 8, bent on justice, finds 6, who is crying, but doing nothing to get into a better place; she puts him into 14, which is very pleasant, but beneath 6's dignity. 7 is already in 14 by the aid of 2. 8 turns out 7, and hurls him into 15, which was a dungeon."

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* "The Pedagogical Seminary," June, 1892.

And so on this drama is carried out, until the combinations become almost innumerable. These true memories are said to be "more clear to-day than the faces of early playmates."

Of course, such a marked degree of the power of visual imagination is indeed rare, and yet it is more common among children than one would be apt to think. George Sand, in recalling her childhood experiences, supplies us with a good example by way of illustration. She also retained this power to quite an extent in later life. "I never look at certain mosses in my herbarium," she says, "without finding myself again under the oaks of Frascati. A little stone makes me see again all the mountain from which I brought it, and recall the same with all the minutest detail from top to bottom. The odor of the *liseron vrille* [bindweed] makes a terrible Spanish landscape appear before me, of which I know neither the name nor the location; but which I passed by with my mother at the age of four." Gustave Doré said, "My mind is my model for everything." A still more interesting case is that related by one of the pupils of Worcester Normal School, of her own childhood. "As a rule," she says, "I preferred story books which were *not* illustrated. This was because the illustrations were *not so beautiful as the pictures which came into my mind* while *lis*[illegible]o, or reading a story. I used to turn the pages over quickly, or if there was print above and below the picture, I used to hold my hand over the picture so that it could not blot out the one in my mind."

3. *The Auditory Type.*—This type is not near so common as the visual type; yet there are many poor visualizers who seem to have extremely good auditory memories. Many musicians seem to belong to this type—those who sing or play "by ear." It is said that Mozart at the age of fourteen, after hearing Allegri's *Miseréré* for a single time, as he was forbidden by the popes to copy it, reproduced the entire work from memory. Professor Stumpf informs us of a child that could follow the scale in singing at the extremely early age of fourteen months.

The difference between the auditory and visual types is well shown in the little anecdote, told by Bernard, of Legouvé and Scribe. "When I write a scene," said Legouvé to Scribe, "I *hear*; but you *see*. In each phrase that I write, the voice of the personage who speaks strikes my ears. Your actors walk; they gesticulate before your eyes; I am a *listener*, you a *spectator*." "Nothing is more true," said Scribe; "do you know where I am when I write a piece? In the middle of the parterre."

To one whose mind revels in auditory images it is no difficult matter to perform what would otherwise be remarkable feats of memory of sounds, as in the example of Mozart cited above.

4. *The Motor Type.*—With persons of this type the mind in its operation deals chiefly with the images of muscular sensations. All of us are quite dependent upon our motor images, especially in the common habitual movements involved in utterance, walking and the like. These simple movements would be quite impossible without these motor clues, as pathology makes plain to us. When the images of certain movements are destroyed, the patient can no longer execute those movements, for example, aphasia, agraphia, and the like. This is the reason that sensory paralysis is always followed by motor paralysis.

The blind depend quite largely upon their motor images. *When engaged* in reflection, all [illegible] themselves, they have been observed to spell out their thoughts with the finger alphabet. Berthier, the deaf-mute, made such a confession of his own operations when he says, "Although my fingers and my hands are immovable, I feel, when I think, that they are in activity. I see internally the image that they produce. I feel that my thought exercises itself and identifies itself with these movements which the external eyes do not see."

Professor Stricker, of Vienna, has this form of imagination (motor) developed to a remarkable degree, and which he himself has carefully studied and fully described.

His recollections both of his own movements and those of objects are accompanied, invariably, by distinct muscular feelings in those parts of his own body which would naturally be used in effecting or following the movement. In thinking of a soldier marching, for example, it is as if he were helping the image to march, by marching himself in his rear. And if he suppresses this sympathetic feeling in his own legs, and concentrates all his attention on the imagined soldier, the latter becomes, as it were, paralyzed. In general his imagined movements, of whatsoever objects, seem paralyzed the moment no feelings of movement either in his own eyes or in his own limbs accompany them. The movements of articulate speech play a predominant part in his mental life. "When after my experimental work I proceed to its description," he writes, "as a rule I reproduce in the first instance only words, which I had already associated with the perception of the various details of the observation, while the latter was going on. For speech plays, in all my observing, so important a part that I ordinarily clothe phenomena in words as fast as I observe them."

If you should inquire among persons as to the sort of terms *in which they imagine words*, most of them will reply "*in terms of hearing*." Not until you draw their attention to the matter will they see that the motor images connected with the organs of articulation predominate. A good way of clearing up the r[illegible] them, is to try the method suggested by Professor [illegible] 'Partly open your mouth and then imagine any word with labials or dentals in it, such as 'bubble,' 'toddle.' Is your image of the word under these conditions distinct? To most people such an image is at first thick, just as the sound of the word would be, if they tried to utter it with the lips parted. Many can never imagine the words clearly with the mouth open; others succeed after a few preliminary trials." Such an experiment proves how dependent our imagination of words is upon the actual feelings in lips, tongue, throat and larynx. Professor Bain goes so far as to say that "a suppressed articulation is in fact the material of our recollection, the intellectual manifestion, the idea of speech."

So then we really have at least four general types of reproductive imagination—the tactile, visual, auditory and motor. In every person one of these types is more highly developed than are all the others. But this extreme development does not of necessity exclude the presence of, and a dependence upon, the others. In the normal individual *all* these types are developed. We use the visual power to retain what has been learned by reading; the auditory power to retain what has been gained by hearing, and the muscular or motor memory to retain what has been committed by recitation. Then in the normal type the reproduced images are sometimes visual, sometimes motor, sometimes auditory and sometimes tactile. We all know how very different reading a foreign language is from speaking it. For three years before I went to Germany, I read some German every day, but never spoke a word until I had actually set foot on the soil of the *Fatherland.* A stock of visual images I found quite different from the motor images, and both of these very different from the auditory images. For I could read and speak German before I could understand it when spoken by others. On the other hand, I have a friend who in the reading of German is quite dependent upon his stock of auditory images. He understands German well when he reads it aloud, but if he reads it silently he experiences great difficulty. You frequently notice old people who continually move their lips when reading mentally, just as they would move them when reading aloud. In some schools and with some children, it is quite a difficult matter to get the pupils to study without moving their lips.

We now come to speak of the constructive, reproductive, or creative imagination. I think teachers, as a rule, are apt to underestimate the importance of this creative faculty. "Without imagination," says Goodwin, "there can be no genuine ardor in any pursuit, or for any acquisition; and without imagination there can be no genuine morality, no profound feeling of other men's sorrows, no ardent and persevering anxiety for their interests."

The constructive or creative imagination may assume at least three forms under which to manifest itself. These may be crudely styled: (1) The intellectual imagination; (2) the practical imagination—the adapting of means to ends; (3) the artistic or poetic imagination.

Intellectual Imagination.—Every extension of our knowledge beyond the domain of personal experience and observation, involves some degree of imaginative activity. The old principle, so often voiced in our ears, that we must proceed from the known to the unknown, depends, in its practical application, upon the extent to which the imaginative faculty is exercised. In the acquisition of new knowledge, every person is dependent upon this power, whether the knowledge be of objects, persons, places or events. It is especially true in the discovery of new facts by anticipation. To illustrate the latter case, take the work of the astronomer in his calculation of the time of eclipses so long beforehand, or the position of the planets on certain dates.

With reference to the use of imagination in acquisition, the general statement may be made that the process of recalling, selecting, and regrouping the traces of personal experience, as applied to the new facts presented, is illustrated in every act by means of which knowledge is gained. Imagination as well as memory is involved in every act called "learning," whether this learning be by oral communication or by books. If you wish to
neaning of a word you must form clear and keen men-
f the objects and events indicated by the word. Thus

in following the account of a battle, the child begins with his own limited experiences called up by the words involved in the description of the battle-scene.

Have you ever seriously thought of the actual fact that what is known as understanding a teacher's description, depends to a great extent upon the success of the pupil's imaginative effort? For example, you are describing an ocean steamer to your class of young pupils, and they fail to comprehend (or image) its magnitude; how can you expect them to realize the functions performed by ocean steamers in commercial navigation? If you are describing a fort, such as existed during the time of the "French and Indian Wars," and you fail to make clear to their minds the necessity of such a protection, how can you expect them to appreciate the difference between a fort made of logs and stones, and one whose walls were simply piles of crumbling earth? Ever and always must our educational methods take cognizance of the fact, that there is a close relation between clear imagination and clear thinking.

Again, in all discovery of new facts we find that the processes of simple observation are greatly assisted by the imagination. The scientific student must ever invent hypotheses for the explanation of facts. In this he is aided by the imagination, for his hypothesis stands or falls upon the, as yet unobserved, results, which results he must picture as fast as possible beforehand. The chemist must picture to his mind the action of certain substances on each other, before he can assure you or even himself of the nature of the compound produced by their being mixed together.

Practical Imagination.—But more clear, perhaps, is the part played by the imagination in the practical line of invention of the various mechanical devices which have proved such a blessing to our generation in the development of our natural resources. Robert Fulton pictured to his mind the advantages of a steamboat before he ever attempted its construction. Could Morse have worked so assiduously, against such discouragements, in his endeavors to perfect the telegraph, had it not been for the picture of the enormous convenience the now indispensable telegraph would prove to the world? That picture was supplied by the creative imagination. It was the same thing that raised Edison from the humble position of a telegraph messenger to that of the foremost inventor of the world. When a poor man, a few years ago, he suggested that a means could be contrived whereby a message could be sent and received over the same wire at the same time. He was laughed to scorn by his fellow workmen. But the cherished image remained in his mind, and as a result of that mental picture which was stereotyped on Edison's brain we have the "Duplex" key now adopted into general use in telegraphic service. The projector of the "Ferris Wheel," which is one of the greatest engineering feats of modern times, was laughed at and regarded as crazy by many whom he approached with his plans. The evolution from the sickle to the "self-binder," in harvesting grain, is the result of the acts of the creative imagination. Every invention, whether it be of a useful mechanical contrivance that has blessed the world, or some artistic design that has made men appreciate the beautiful—every single invention finds its genesis in the imagination of some individual.

It is in a sense fortunate that children possess this imaginative faculty to such a degree. That they do possess this power is seen so plainly in their plays and games. I have seen children in playing, use as dolls such various articles as a stick of wood, a knife, a clothes-pin, a newspaper, an ear of corn, and a milk can. You remember the remark of Budge in "Helen's Babies," who said "We doesn't like buyed dolls." A wax doll with flaxen curls is a fine thing to have laid away in the bureau drawer—to look at semi-occasionally; but for good, rollicking, genuine, every-day fun the child chooses the old rag doll. A toy is not something to look at and observe merely, but it must admit of being done something with; the more possibilities that the toy offers in this line the better toy it is.

Likewise in their attributing personality to inanimate objects. A little boy eighteen months old tried to make his doll eat bread and cried when he found it could not be made to eat. Children love to think of their toys and of other objects, as living things. Mr. Russell reports the case of little Hildur, a child aged one year, seven months. "Just as Mrs. L. brought Hildur in, I accidentally knocked a chair down on the floor. Hildur began to cry, and when I called her she did not move. I went towards her, at the same time picking up the chair. She ceased crying as soon as the chair had been picked up. About ten minutes later, I put the chair down on the floor again, and as soon as she saw it, she began to cry, and when I picked it up, she stopped."

That children attribute sensibility to objects, especially a capacity for suffering, is quite a well-known fact. I remember well, a little boy who wanted his mamma to whip the wind for blowing his hat off. My own little girl has often asked me on seeing me light the open fire in the grate, "Papa, don't it burn the fire and hurt it when you make it blaze so?"

The average child seems to live half his life in a world of make-believe. How often do we hear children say to each other, "Play you were so-and-so," or such remarks as "I'll be the papa and you be the mamma, Mary will be the hired girl and the rest will be the ladies who came to see us." And the imaged objects are to the child *real* objects. Not long ago my little girl was playing Sunday-school, laying especial stress on instrumental music and "the collection" as the more important features of the ideal Sunday-school. She was using a chair for her piano, and while she was out of the room for a moment her mamma sat down in this self-same chair, without thinking of its newly assigned function. Gretchen, on coming into the room, noticing her mamma seated in this particular chair, exclaimed in a painful way, "*Oh mamma, you are sitting on the piano!*" Again, one day she and her brother Stuart were playing that they were keeping house. Gretchen was the "mamma," and Stuart the "papa." When called to luncheon Gretchen got to the wash pan first and was preparing herself for dinner, at the same time teasing her brother with the thought that she was going to beat him to the table. Stuart burst out crying with the exclamation—"Oh, Gretchen won't let 'papa' (meaning himself) *have the basin.*"

Many children seem to actually believe that it pains flowers to tear or burn them, that in the summer when the tree is alive it makes it ache to chop or pound it. Thunder, which is an unaccountable mystery in the child world, is said by some children to be God "groaning" or "kicking." Others say that it is caused by God "rolling barrels about," "turning a big handle," "throwing logs," "having coal run in," "hitting the clouds," or by the clouds "bumping together." Most of children's fancies seem to cluster about the sky, sun, moon and stars.

When the dew is on the grass the child says, "The grass is crying;" when the stars come out they are "candles" or "street lamps lighted by angel boys," or they are "sparks from fire-engines," or "cinders from God's stove." Butterflies are conceived by some to be "pansies flying," and others call icicles "Christmas candy."

Play offers a wide scope for the child's practical ingenuity. Play owes its chief charm to mimicry and a kind of make-believe of the action of adults. Much childish play owes its charm to a sort of partial self-deception. Children imagine or make believe they are animals, soldiers, Indians, hunters and veritable Davy Crocketts, Daniel Boones and Buffalo Bills. They play church, school, circus or congress. If hit with imaginary bullets from imaginary guns they fall down and play they are dead. If they step on a crack when walking on the sidewalk, they are "going to have bad luck" or are "poisoned." What child has not played with mud pies, moss carpets, brooms made of pine tufts, cucumber pigs and horses with eyes of tacks, or a train of cars made of chairs? All this is done by the "alchemy of the imagination." Only a rough basis of analogy is needed for these creations of fancy. A boy will derive as much and even more pleasure from riding a stick as he will from possessing the most richly caparisoned hobby-horse.

This same imaginative exuberance manifests itself in another form. A child who has heard a number of stories will display [illegible] ivity and ingenuity in inventing new ones. This free, [illegible] us fancy is apt to assume extravagant shapes and exaggerated colorings. Thus one teacher reports that Alfred, aged six, "was dining at our house to-night. During dinner one of the company told of a horse-chestnut tree that had red blossoms. Myfather said he never heard of red blossoms on a horse-chestnut tree before, and wanted to know on what street it was. On hearing this A. said, 'My teacher told us to-day of an apple tree and the blossoms on it were blue.' He was asked, 'Did your teacher tell you where it could be seen?' A. answered, 'Yes, but it's down on Winter street in Boston, so you can't see it.' My father said it would be worth while to go to Boston just to see that tree, and he thought he could see it when he went on Wednesday, since he knew what street it was on. A. did not say anything for quite awhile, and then he suddenly spoke up, remarking, 'I forgot to tell you that a storm knocked all the blossoms off that apple tree, so I don't think you can see it.'"

Children are apt to find great excitement in the marvelous, and they delight in turn to excite others. This frequently leads them to tell their grotesque stories surcharged with everything but truth. "To fly up to the sky" is not an impossible act for the average child to perform.

The indulgence in these pleasures of fancy and the imagination involves certain risks if entirely uncontrolled. It is, however, legitimate within certain bounds and should be stimulated, in a large measure, in early childhood. In later youth the exaggerated exercise of this power may involve dangers, both moral and intellectual. The child that lives always in the world of wonderland, and dwells continually on the romantic figures clothed by the imagination, may be unable at the proper time, to adjust himself to actual surroundings, and he will naturally grow discontented with the world as it is, continually chafing because out of harmony with life as actually lived.

Or such an one may become thoroughly satisfied with this image world, created by extensive and prolonged indulgence of the imagination, and in this way be rendered incapable of dealing with real objects as they present themselves to his sensorium.

Again, it can be readily seen, that if the imaginative activity is thus divorced from the really fixed mental standards by which the correctness of reasoning and other intellectual processes is discerned and passed upon by the judgment, the attainment of truth in all investigation and research is hindered. When the imagination is given over to the sway of the emotions, rather than to the control and guidance of the intellect, the sway of feeling gives a capriciousness to the workings of the imagination, rendering this creative power utterly unfit for the calm and steady pursuit of truth. The student whose imagination obeys the behests of feeling is prevented from clearly discriminating among the facts he is trying to investigate in an unbiased way, and becomes the victim of vagueness as well as exaggeration. In evoking one's stronger feelings, imagination puts a cataract over the eye of judgment, rendering the mind of the student unfit for cool, scrutinizing, careful, painstaking investigation and research.

But when properly guided the imagination is of immense intellectual value. It is, as has already been stated, indispensable in teaching, in invention, in study, in passing from the known to the unknown. The teacher must orientate himself into the child's world—put himself in the child's place—in order to know just what sort of mental *ménu* to place before the child—that he may know just what food is best calculated for the child's intellect to digest and assimilate at each stage of development.

The ordinary practical person is apt, at first thought, to sneer at the imagination as if it were a useless appendage to the mind—a sort of "peacock's tail"—beautiful, brilliant and gay, but serving only to retard the progress of real mental growth. We are quite apt to overlook the intellectual service rendered by this faculty in the pursuit and acquisition of knowledge. But a deep look into the mind as a whole, an organized unit, reveals to us the fact that the imagination, instead of being opposed and antagonistic to the intellect, constitutes an essential factor in the intellectual processes and in mental growth.

[illegible] normal person, after the early childish fancies have [illegible] for a term of years, moderation comes of itself as a natural result. The child becomes more matter-of-fact, and his early spontaneous fancies pass into more regular forms, controlled and directed by an enlightened will. This is evinced in the mental revels of the child. The activity of the imagination now becomes more and more influenced by the sense of what is true and actual. He can no longer be satisfied with a sky-blue hippopotamus, the old nursery tales or fairy stories. He likes to hear stories that are in actual touch with real life. He prefers accounts of the actual or probable doings of children to all the literature of the Jack-and-the-Bean-stalk variety. Still it is unfortunate if this period manifests itself too early in the child's course of development. He will be all the stronger and more powerful as a thinker, certainly more original, if he spend his earliest years in contemplating fancy's pictures.

How delightful to be an *unobserved* listener at children's games! Oftentimes have I concealed myself behind the trailing vines that clamber up over the piazza, to hear the conversation of a covey of young children on the lawn below. How easy then to see the relation that obtains between the wilder and more rambling ravings of the imagination, and the period of the child's development! The average child of three or four years will be quick to tell of a pig with six legs, a horse with three ears, a mouse as big as a dog, blue apple-blossoms and pink cats. But the older child will at once correct these tales by their own standards, gained from real experience. Children will tell their semi-plausible stories as long as the listener will express astonishment. When his accounts no longer evoke wonder, the child is very apt to part company with pseudomania. I have observed children play contentedly in their world of make-believe until they discovered that I, an alien, was looking on, when they would become confused and run to me quickly to explain that they were only *playing*, seeming half ashamed of the fact that they were reveling, in their play, with imaginary entities. In this way, it occurs to me that of itself, the early imaginary impulse in its crude form is replaced by a desire to learn about things, and by a regard for what is actually true in the world of external nature and of life itself. The imagination gradually becomes a handmaiden serving the ends of knowledge. The toys no longer serve as "lay figures round which the child may weave and drape his fancies." He prefers a more real life. In this connection it is interesting to note the following quotation from Mr. Newell's "Games and Songs of American Children."

"Observe a little girl who has attended her mother for an airing in some city park. The older person, quietly seated by the footpath, is half-absorbed in reverie; takes little notice of passers-by, or of neighboring sights or sounds, further than to cast an occasional glance, which may inform her of the child's security. The other, left to her own devices, wanders contentedly within the limited scope, incessantly prattling to herself; now climbing an adjoining rock, now flitting like a bird from one side of the pathway to the other. Listen to her monologue, flowing as incessantly and musically as the bubbling of a spring; if you can catch enough to follow her thought, you will find a perpetual romance unfolding itself in her mind. Imaginary persons accompany her footsteps; the properties of a childish theater exist in her fancy; she sustains a conversation in three or four characters. The roughness of the ground, the hasty passage of a squirrel, the chirping of a sparrow, are occasions sufficient to suggest an exchange of impressions between the unreal figures with which her world is peopled. If she ascends, not without a stumble, the artificial rockwork, it is with the expressed solicitude of a mother who guides an infant by the edge of a precipice; if she raises a glance to the waving green overhead, it is with the cry of pleasure exchanged by playmates who trip from home on a sunshiny day. The older person is confined within the barriers of memory and experience; the younger breathes the free air of creative fancy."

Again, every teacher knows, or ought to know, that if we seek to get clear ideas respecting the nature of the objects of admiration and love which keep the lives of children sweet and wholesome, we find that all the kinds of love and admiration which decide whe the general tenor of their life, the relation in which
d to their fellow creatures, what shall be the occu-

pation of their leisure time—I say all these certainly fall into two great classes: (1) Those interests which center in the study of nature [botany, geology, zöology, and the like]; and (2) the class of studies that inquire into feelings, actions, and thoughts of man himself. All the interests which keep human life in the right channels belong to one or the other, or *both* of these two classes. Have you ever fully realized that no human being can live a healthy, normal life unless he admire nature or the best and highest thoughts, feelings, and actions of man? The men of fine texture, the men of fine heart and brain fiber, the men of true nobility, are men who have been deeply influenced by admiration and love of nature. *But such admiration can never be made possible without the presence of the idealizing faculty—the creative imagination.*

You well know that a great poem or drama, a book of travel, a descriptive narrative, written by a man who loved nature, can hardly be said to exist for those who do not themselves know nature, for they cannot orient themselves into the writer's thoughts and moods. The children who are growing up in our homes, and more especially in our crowded cities, in ignorance of all such things as flowers and trees and birds, are ignorant also of all kinds of human achievements made beautiful in form or color; the place in the hearts of these children, that ought to be filled with feelings and thoughts supplied by beautiful things in nature and by the beautiful products of human art, is filled instead with feelings and thoughts evoked by a little shrunken, shriveled world of small, grimy houses with gloomy surroundings.

How fortunate it is that the child naturally seeks for the beautiful! But you must remember that the beauty the child gains in his quest, is found to be beautiful because it corresponds to a certain ideal (crude though it be) supplied by the child's own creative imagination. I know a certain teacher who was most tactful in discipline and most delightful as an instructor. Every one of her scholars thought her beautiful. I remember one exuberant boy saying, "Miss M. is the most beautifulest lady in the world. She's just handsome." And yet as a matter of fact she was the homeliest person I have ever seen. The beauty the boy perceived was an ideal beauty, but based upon certain qualities which evoked the child's admiration and love.

I was recently made acquainted with the following little incident, by a friend: "I asked a ragged little child on the street," said this friend, "which she would rather have, the red carnation in my button-hole or a dime. She eagerly took the flower. Nor could I induce her to exchange by extravagant stories of all the nice things she could buy with the money. She only clutched the flower the tighter." This little scarlet blossom corresponded to the child's ideal of beauty. This ideal was supplied by the imaginative faculty.

Experience has proven that a large proportion of persons who have attained the age of thirteen, ignorant of reading, writing and arithmetic, and yet have, after that age, learned as much reading, writing and arithmetic as they needed to lead useful lives. But alongside this is the other fact that experience has also demonstrated, that persons who reach the age of thirteen without admiring and loving admirable and lovable things, seldom make good that defect in after life.

What objects of sympathy those vacant-eyed children are, who, though they look at you, do not see you! "Joe, what are you thinking about?" "I ain't thinking of nothin'." Right here is made plain the function of the modern kindergarten. In the kindergarten the child plays again and again with the same little box of blocks, eight in number and alike as to shape. He soon finds how readily they respond to his fancy, and takes delight in them day after day. His experience is the same with respect to the sheet of paper, the lump of clay and the little bundle of sticks. You can see then, that a new idea is graven upon his mind—*How much can be done with how little!* Is not this a most important idea for the child to grasp and retain?

What significance it has for his after life! How much is gained by the child who has revealed to him, in his kindergarten life, the superiority of a pleasure that comes from the use of *his own* [illegible] *power* upon simple, crude material! Then it is that he lives the sentiment of Carlyle's noble thought—"Not what I know, but what I do, is my kingdom."

I have in mind now a very industrious little fellow, but who was the most unimaginative child I have ever known. He had no sense of humor whatever. But when put into the kindergarten it did not take long to develop in him a most decided sense of humor, and the keenest perception of fun. In a short time he was transformed from the grim, sober, playless little child into one lively, happy, and vivacious.

Not long ago I spent a few moments in observing a band of these sunshiny kindergarten chicks at their morning games. My little Gretchen was a member of the group. Her nut-brown hair falls in graceful curls to her shoulders. One keen little fellow, who was occupied with a cylinder, noticing these, exclaimed, "Oh, Miss Kate, Gretchen has cylinders on her head!" Gretchen began to feel all over her head with her hand to find the wooden blocks, as she supposed. All this time the little fellow who made the remark was shaking his sides with laughter. After awhile the rest of the children, and Gretchen herself, saw the joke. Without an active imagination the relation between the curls and the wooden cylinder would never have been perceived by the keen, bright-eyed child.

Although, through the child's added sense experiences and the development of his powers of judgment and reasoning, the wilder ravings of his fancy become curbed, it is a serious mistake to suppose that the imaginative power ceases to grow. It simply "changes tack" and follows more fruitful and beneficial lines than it did in earlier childhood. The power of the youth's constructive imagination goes on developing, at the same time inducing a gradual enrichment and deepening of all his mental faculties. Why can the child of twelve follow the narrative of a historical book, or book of adventure, better than a child of eight? Simply because his higher development of the constructive imagination enables him to group the elements of recorded experience with greater facility.

It is a comparatively modern notion that the function of the true educator involves the guidance of the imagination of his pupils as well as their other mental powers. Formerly it was conceived that if the educator had anything at all to do in the guidance of this special faculty, that guidance or direction should take the nature of a smothering or repression of its activity. It is a delightful relief to note that a marked change in point of view has come to pass with reference to the way in which the child's creative fancy should be treated by the teacher. It is refreshing to observe that the modern, wide-awake teacher is turning his attention more and more to the problem of helping to develop the imaginative faculty in some worthy manner, such as will contribute to the mental health of the child and retain harmony among all the powers of mind—the harmony that characterizes the normally developed child.

That there should be some educational discipline of the imaginative faculty goes without saying. But this discipline should by no means be a repression of the power itself. It is a source of great regret that educators have been apt to overestimate the evils of indulging in flights of the imagination on the part of children. The child's imaginative creations are most natural to the mind at its early stages of development, and assist in inciting it to new achievements and further development. Furthermore, it is most important and appropriate that the child create this fairy-like world, if the best elements of his mental make-up are to be conserved. Natural? What is more natural than the following incident from the life of a boy: "Six-year-old A, had found a dead hen. He got a few old papers, some twigs and a few sticks of kindling wood, and piled them up in a regular way; he then cut off a few pieces of twigs that stuck out. He put the old hen on top of the pile and set fire to it. His mother came out just as the fire commenced burning the hen, and she asked him what he was doing. He replied: 'I am offering a sacrifice for the sins of all the neighbors.'"* Observe almost any normal child from day to day, and see the thousand and one im[illegible]cts which he is impelled to perform by the influence of

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[illegible]lection of observations at the Worcester Normal School.

his irrepressible imagination. Do this even for a short time, and you will be fully convinced that the child's creative fancy supplies a large portion of that little world in which he lives and moves and has his being. Furthermore, the so-called harmful effects are found to be very temporary and evanescent in character.

You see, then, that while in certain directions and on comparatively rare occasions the educator has to check and impose a limit upon too extravagant an activity of the productive imagination, his larger obligations to the child make it really incumbent upon the teacher to aid in the development of this faculty. No better preparation for the serious work of later years than the spontaneous and playful exercise of this creative fancy can be conceived. Do not—as you value the child's mental development—do not be too anxious to check the childish vagaries created by his imagination. Neither intellect nor character will be harmed by them, and to a large extent they may be left to correct themselves.

While it seems to be the rule that imaginative children are at first slow at their lessons in the more matter-of-fact school work, it is also true that the child whose imagination has been well directed by helpful stories and descriptions, will, other things being equal, be the best learner at school. What better exercise than these stories that appeal to the imagination of the child can be devised for cultivating the child's power of concentrated attention, so essential to learning in the school and to all mental advancement? Besides, it is a question—a most serious question—whether it is a part of wisdom to have the curriculum of the primary grades made up of the matter-of-fact studies. Far better for the child, is the revised one-syllable edition of "Robinson Crusoe" than the old barbarous attempts to teach him the abstract multiplication table. Early, careful nurture of the imagination, by means of wholesome and well-selected food, has a great deal to do in determining the scope of intellectual activity that is ultimately attained by the child.

Of course, to train the imagination wisely the educator must *pay close attention* to the natural laws of its operation. In im-posing tasks upon the child, that involve the activity of the constructive or creative imagination, be very careful to make those tasks simple and adapted to the stage of the child's development. You can never be successful in calling the child's imagination into exercise, unless he has an ample stock of those experiences out of which the picture must be constructed. The child cannot make one single advance step into the world of the unknown unless he can construct analogies. I remember once, when trying to instruct a couple of very young children as to the appearance of a mountain, I gave a rather elaborate description of its elevation and general appearance, but one of them — a little four-year-old — did not seem to comprehend. But his sister, only a year older, made it perfectly plain to him by telling him "a mountain looks like a great big chocolate drop — bigger than all the houses and all the trees." Her simple analogy, so crudely expressed, did much more to instill clear ideas into the mind of that child, because it was in touch with his limited stock of actual experiences.

Again, in cultivating the imagination you must call it into exercise gradually. You must suit the image you bring before the child's mind, not only to his stock of experiences with actually perceived objects, and with due regard to the order in which the faculties unfold and develop, but your images must be suited to the degree of imaginative power already attained. Don't spring a complicated story of adventure on a child who has never heard the simpler traditional stories of babyhood.

Furthermore, due notice must be taken of the main condition of success in all instruction — the awakening of keen and lively interest. If you are seeking to call the child's constructive powers into play, you must provide materials that appeal to his feelings. Without appeal to the child's feelings of sympathy, amusement, admiration, pathos and the like, no lively interest will result from your efforts, be they ever so great.

So much "Children's Literature" is insipid, flat, and uninteresti[illegible]ecause the above-mentioned pedagogical principles are [illegible]l. Those painfully didactic, "namby-pamby," "goody-[illegible]ories in little green books with chromo covers, such as used to be presented to us as a "Reward of Merit" by our Sunday-school teachers, never succeed in gaining the attention of the average child, because they are not properly gauged to fit his experiences or evoke his interest. This "sugar-water" literature is as deleterious in its effects as are those books in which the writers describe scenes and impressions quite beyond the child's mental reach, because they cannot look at the world with the eyes of a child, but retain their red and blue spectacles of prejudice and old-fogyism. The book of the child must be clear and free from all allusions that are above and beyond him, but it must also be not too simple, leaving no room for his creative power. To give a child a book whose contents leave no place for efforts of the imagination is as ridiculous as to tell an adult person—a full-grown man—sitting for a picture at the photographer's, "Now watch closely and listen, and you will see the kitty or hear the birdie;" on the other hand, to give the child too "old" a book is as absurd as to tell a three-months old baby, when trying to get its first picture, "Now smile, look pleasant and don't gesticulate."

A problem beset with many practical difficulties, arises when we begin to discuss the exact nature of the training we would give the child's imagination. It was shown earlier in the chapter that there are great individual differences among children with respect to imaginative power. Not only are they representatives of the tactile, visual, auditory or motor type, but they differ widely in their ability to combine the raw material of thought. These great individual differences that we find in children, with respect to both reproductive and creative imagination, are of utmost importance to education and must be borne in mind in every discussion of pedagogical method.

In view of all these shades of differences that characterize the tactile, motile, visual and auditory types respectively, as well as the differences in creative power, manifested in all degrees, from the stupid, prosaic child to the most confirmed idealist—in view of these differences, many questions of vital interest arise within the mind of the educator. Is one type of mind better than all the others? If so, should the teacher tear down in order that he may reconstruct the child? Should the teacher conform his methods to the child's type of mind, using pictures, reading charts, diagrams and the like, for the good visualizer; kindergarten occupations, sloyd, reading aloud, and other oral exercises for the motor type? Or should the teacher, on the other hand, check any tendency to specialize in any one class of mental images? Should the child be permitted to deal in only one "line of goods?" Should the teacher aim to supply deficiencies, *i. e.*, should he seek to transform the poor visualizer into a good visualizer? Should he seek to develop the child equally well along all lines traversed by the imagination in its activity?

To illustrate what I mean: Should the teacher, in teaching the alphabet (if the alphabet should be taught at all), first accustom the child's ear to the sounds, then appeal to the motor images and teach him pronunciation, and finally the forms of letters, as some prominent writers maintain? Or should all three of the operations be carried on at once, each re-inforcing the other, which is, I believe the prevailing custom? These are questions which cannot be answered without appeal to experiment. A system of tests ought to be devised and accurate records preserved. Such experimental tests have not as yet been made. For a time, then, we must hold our questions in solution until experimental pedagogy determines the best path to follow. Of course here and there we can make special observations and special applications in individual cases. But as yet there is insufficient data to guide us to well authenticated general conclusions.

In whatever way these questions are answered by future appeal to experiment, certain it is that the different degrees of development attained by the imagination, as well as the different tendencies of this development in different children, must account in a measure, for the oft observed fact that a group of children, surrounded by the same educational influences, make such different progress. If the teacher lay especial stress upon the eye-method, [illegible]ill most certainly handicap those of the class who think [illegible]n auditory images, and vice versa. Again, manual training, drawing, writing, clay modeling, all appeal to the child's stock of motor images. Instruction in gymnastics and athletics is one of the best methods of training the child in this line, as musical instruction is the best method of training his power of imaging in terms of audition.

While we cannot treat of each of the methods in detail, we are inclined to the view that in education we should use every avenue to the mind, that is open—every sense should be appealed to; eye, ear, hand, muscles, etc., should all be made use of in securing normal development, for all the strings of the soul's harp must be in tune if there be harmony and not discord when the demands for activity are made upon it by the emergencies of practical life.

It is greatly to be feared that each teacher will adopt that type of instruction which proceeds in terms of his own method of thinking. If he be a good visualizer, he will instruct his class in terms of visual images; if he belong to the auditory type, he will color all his methods with the auditory hue, and likewise as to the motor and tactile types of instructors. Teachers are apt to think that their pupils have the same way of regarding things as they themselves. So our professional teacher, who finds one method suited to his type of mind, will adhere to it as the only method and be blind to the good features of all other methods. No method has ever been devised that will admit of universal application. In closing this chapter, we must reiterate, that in the work of instructing a child, the teacher must always exercise his own powers of imagination, and must also appeal continually to the germs of imaginative effort which are present in every normal child.

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LESSON XXII.

REASONING.

WHENEVER the mind passes from one fact to another in thought, considering the first as a sort of sign or indication of the second, it is said to reason or infer. To infer is to find out what will be true, on the basis of something else being true. Thus I infer when I say: "If this gunpowder is damp, it will not explode." Or, if on looking out of the window we see the sky overcast with threatening clouds, and as a result of this observation predict rain, we are said to be engaged in a process of reasoning. You tell the child that if he touch the cake of ice with his hand, his hand will feel cold. The conviction that you have, and which you express to the child, is based upon an observation of certain of your own experiences, which observation has led you to regard "coldness" as an essential mark or attribute of ice.

The real basis of inference is found to be a discovery of similarity among facts or experiences. You awaken in the morning and glance at the clock on the mantel-piece to learn the time of day. You know that this particular object is a clock because it corresponds to the remembered image of clocks you have already seen, including this one. It looks thus and so. It has a dial, hands, certain characters or figures on its face, and ticks, just like other clocks. Because it looks thus and so, you feel justified in saying that it is a clock, and you do so by a process of reasoning. Suppose the clock is not ticking, you reason at once that this particular clock has stopped, for all *going* clocks that you have observed heretofore do tick. You sleepily turn your eyes toward the window and you see it is quite light out of doors. Just then you hear a shop-whistle blow. You infer that it is time to get up because it is light, and you infer further that it is seven o'clock because the particular whistle you heard always "blows" at [illegible]ck. Then you begin to dress. Every act in this procedure is based upon reasoning of some sort or other, though the reasoning process itself may be abbreviated. You do not begin your operations by first putting on your hat, shoes and necktie, for that would be an *unreasonable* method of procedure. You seat yourself at the breakfast table because you know from previous experience that in order to get your breakfast you must be seated at the table. You eat certain foods, knowing they agree with you. You say, "Good morning, Mary," because by an act of reasoning you know that "Mary" looks thus and so, and this person looks and acts the same way, you conclude that this person before you and Mary are one and the same person. In all these mental processes you are basing your conclusions upon the detection of similarity among facts and experiences, just as you do when you predict a shower on observing the clouded sky, you identify the present appearance of the sky with previously observed appearances which were actually followed by rain. In inference, therefore, we identify things or events in their relation to other things or events. You can see also that this is indispensable to mental progress, for by means of this capacity of inference we can proceed from facts actually seen and observed at the moment—the known fact—to other facts that we do not have before us at the time—the unknown.

Do you realize that all of us are reasoning every movement of our wakeful consciousness? Of course one is not always conscious of going through a process of reasoning. You say you *see* the clock, you *hear* the whistle, you *know* it is seven o'clock, and so on, when you really *infer* in each case. When I say, "Wet gunpowder will not explode," I am expressing in an abbreviated form an actual process of reasoning. I look out of my study window just now and I say, "The ground is wet." But I cannot see the ground at all from where I am sitting, yet I know the ground is wet, for I see it raining. So when I say the ground is wet, I have actually reasoned in such form as this

When it is raining th
It is raining.
Therefore, the gro

When one is not conscious of the actual reasoning process, we say in such cases, his reasoning is *implicit*. In this lower and abbreviated form of reasoning, one passes in thought from one fact to another fact without *explicitly setting forth the ground or reason of the conclusion.* Thus the child will infer that water will wet, without making clear to his mind the general principle that all water wets. When he breaks his toy and says, "I can't mend it, but papa can," he does so without being conscious of the general truth that lies at the basis of his statement, namely, that his father is more skillful in repairing broken toys than he is himself. We call this *implicit* reasoning, because in this method of inferring from particulars to particulars, certain general principles or conclusions are *implied*, but not expressed.

This is, of course, only the lower type of reasoning. It is a very primitive and instinctive mode of inference. The lower animals infer as to the proximity of prey or the approach of enemies in this implicit way. Children likewise draw conclusions in the same informal manner. Certain it is that the *first* reasonings of a child are of this character. The child sees a round, smooth, red object and says: "I want the apple," thinking that this round, smooth, red object possesses certain potential tastes as have other round, smooth, red objects which he has been taught to call apples. All such recognition is the product of reasoning. You observe a man passing by your dooryard. You say: "That is the same man I saw at church last Sunday." When asked why you think so, you reply: "I know it is the same man because he has such and such a shaped face, a peculiarly trimmed beard and wears a suit of clothes of a certain particular shade of gray," and so on, enumerating various characteristics that distinguish him from other men. That is, in enumerating your reasons for believing the man who is now passing to be the same man as the one you [illegible] at church, *you state explicitly what was previously im*[illegible] thought concerning the matter. The child [illegible] the window and observes a man opposite the [illegible] r a mere glance, screams with delight: "Oh, [illegible] little toddler is engaged in implicit reasoning, which if expressed explicitly would probably be after some such form as this:

> The man I see coming looks thus and so.
> My papa looks precisely the same.
> Therefore, the man I see coming is my papa.

You can quite readily see the importance of distinguishing this crude, implicit reasoning from what is called in logic formal, or explicit, reasoning. In the latter process, if we reason according to rule, the mind seizes hold of a general truth which is made the ground of certain conclusions with reference to the particular facts under observation at the time.

There are certain advantages that accrue from following the formal mode of procedure. You can readily see that so long as the child passes instinctively from one fact to another, and proceeds on the ground of similarity alone, his conclusions are apt to be more or less uncertain and dubious. Thus the little boy of three and one-half years, who was always anxious to explain everything, and who, when asked what made his hair curl so tight, replied, "Why, it's because I eat so fast," fell into error because he had no acquaintance with certain general principles that would have guided him aright in his search for a cause. If one should infer that all apples are good for food because one apple is good to eat, he may be mistaken. Another example of such false reasoning is the case of the little child, less than four years of age, who was seated at the window watching the falling raindrops in the passing summer shower. Suddenly she spoke up: "I would like to stand out in the rain, mamma, because the rain makes you grow bigger." I find in my diary an account of a similar incident in the life of my little girl. It occurred when she was four years and two months old. She had been denied the privilege of going barefoot, the weather being too cold. At night, when being put to bed, she asked her mamma, "Does God wear shoes and stockings?" and when told that it was pretty hard to find out whether he does or not, she spoke up, "Well, if he don't, he must have a [illegible] as to the case of the child who thought thunder was caused by God "driving his chariot over bridges." Or another, who thought when it thundered that God was "having his coal run in." You cannot pass from one fact to another on the ground of similarity or analogy, with any degree of assurance that your procedure is correct and authentic, or that the results are valid.

We now come to speak of the two modes of reasoning, the *deductive* and the *inductive*. As already stated, reasoning involves a procedure from the known to the unknown. We reason from known particular facts, to unknown particular facts. Now, when we appeal to a universal proposition to prove our conclusions, the reasoning is called *deductive;* it is *inductive* reasoning when we reach a general truth or principle by observation, examination, and comparison of facts. In induction we proceed from fact to fact, until we substantiate some general law. In deduction we apply the general truth thus attained (and usually reached by the inductive process) to some particular case. The child knows that his "kitty died." He observes that birds die, chickens die, mosquitoes die, and so after awhile he finds a certain fact to be a common characteristic of all animals; then he announces the higher general truth that he has reached in the words, "all animals die." This is a process of induction. On the other hand, we have abundant examples of deductive reason in the applications that children make of certain of the more general proverbial sayings—those that have become common property. The following is a case in point:

"Georgie, what made you go over and play with the Smith children when you have mumps and they have not had them?"

"Well, didn't the Sunday-school teacher say it's more blessed to give than to receive?"

Or the interesting recorded observation of a child of four, for which we are again indebted to Mr. H. W. Brown:

"R.'s aunt said: 'You are so restless, R., that I cannot hold you any longer.' R. replied 'Well, cast your burden on the Lord, e, and he will sustain you.'"

e child's mind be impressed with the truth that "all animals die," and he knows his pet dog is an animal, he concludes that his dog must die. In so concluding he reasons by a deductive process.

In inductive reasoning we are simply carrying on the processes that lie at the root of all thinking, namely, the detection of similarity and diversity. In a previous chapter you were told that the cultivation of any avenue of sense depends upon the discriminative ability of that sense; it can also be said that in the same way the expansion of the powers of judgment, comparison, reasoning, depends upon the discriminative ability of the mind in discerning the relations in which things are similar and dissimilar to each other. We are ever occupied in tracing out similarities in a diversity of things or seeking out differences among things that are apparently similar.

You have already observed that children draw conclusions mainly from particular facts, just as some of the higher animals do. Thus the boy who planted a three-cent-piece in the ground, in the hope that he would soon be rich, "for the money will grow, Mamma," implicitly argued that all things tend to grow when planted. The inductions of children and the uneducated are frequently of this type: "Last night as I was going home from school, a man passed me with a load of wood drawn by a small donkey. There were three or four little boys playing across the road. One of them said: 'That's a dunkee.' 'No, it's a horse,' said another. 'No, sir! it's a dunkee because its ears go this way,' at the same time taking hold of his own ears and wriggling them back and forth." * The conclusion of this boy was certainly based on a narrow and precarious foundation. But it is no worse than the reasoning employed by the woman who said she was glad her husband (a laborer) worked nights because "by working nights he saves his lodging; and sleeping in the day time he saves his board." And even this specimen is more creditable than the argument employed by her more wealthy sister of the "upper crust," when she insisted that she really had some money on deposit at the bank because there were still some blank

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* *Reported by H. W. Brown of Worcester Normal School.*

leaves in her check book. Such pseudo-reasoning must be corrected by the education that comes with a wider experience. The natural impulse to build up general conclusions, so inherent in the child's make-up, must be regulated to avoid landing in error. Thus the child, who argues that only *white* cows give white milk, and only *cold* cows give cold milk, soon learns that his conclusions are hasty and inaccurate. He learns to become more cautious. The impulse to include particular facts under general truths begins to feel the exercise of a guidance and control so much needed. He becomes, from this time on, more methodical in his thinking.

Without any question, the most important of all the truths reached by this inductive mode of reasoning is that concerned in the search for causes of events, phenomena and things. In order to bring about any result in practical life or in scientific investigation we must know all the regulating conditions and determining causes. The chief aim in all human investigations, especially in the realm of scientific study, has ever been to discover the causes of related phenomena. This is the stimulus of all research into the puzzling and intricate questions that pertain to the physical, mental, social and ethical worlds in which man is implicated. In the oldest records of human speculation, we find that the fathers of philosophy — the early Greeks — were assiduously engaged in this search for causes. The great problem before the most ancient of these philosophers was to find the cause of the world. Thus Thales found water to be the cause of all that exists. Water, which makes the grass grow, which is necessary to life, which is the chief ingredient of the blood, was to Thales the basis of all existence. You see that in the childhood of the race as well as in this enlightened epoch, men were actuated by the desire to find some great principle that would explain the world as then known.

As this was the case in the childhood of the race, so it is t[illegible] the childhood of every individual, namely, the endeavor [illegible] cause or reason for any occurrence that may have [illegible]rved by the little eyes, ears, hands, etc. In his daily experiences, through the avenues of sensation, the child is constantly being made aware of the outside world, and the various phenomena which take place within its domain. Events and occurrences are constantly being presented to him. Day by day these events are revealed to him in relation to causes. It does not take the child long to learn that water quenches thirst, that fire burns, that food satisfies hunger, and that a bruise pains. Neither is the average wide-awake child long in discovering that he has power to act, and by acting can produce certain results. The little fellow is quick to perceive that shaking a rattle-box produces a noise, that a piece of twine will break, that with his shovel he can dig in the sand, that with plastic clay he can mould innumerable shapes, that by pressing the button he can ring the electric bell, etc. A little later in the course of his development, prepared and at the same time prompted by previous experiences, he begins to perceive that things in nature about him are causally related to one another, after the same manner that effects he produces are related to himself.

For example, he thus learns that the warm sunshine will melt the ice; that overhanging black clouds will produce rain; that rain will make the ground wet; that intense cold will freeze water into ice; that frost ripens the nuts and makes them fall from the trees—and so on indefinitely. Now it would be impossible for the child to have a fund of such experiences without having it somehow suggested to his mind that there is such a thing as "cause." He climbs step by step in his scale of observation, examines the experiences of all his senses, and finally comes to the conclusion that *there is no such thing as an uncaused event.* This he soon adopts as a universal principle governing all future investigation and inquiry.

Along with these developing experiences, by means of which the germ-idea of causation (innate in every individual) is unfolded until it has a precise meaning and definite content, accompanying this process there is that natural inherent impulse which leads *him to inquire* into the causes [illegible]gs. It seems that nearly every normal child is a sort of animated interrogation point. What question is more frequently asked by the child than "Why?" And did you ever see a child who would not make his own inferences as to the causes of things, if his question "Why" remained unanswered?

These natural inductions begin at an exceedingly early age and the very spontaneity of this impulse accounts for the many hasty conclusions which may prove erroneous. The slightest analogy between things will frequently lead the child to conclude that they have the same cause, when they are really entirely disparate phenomena so far as causal relations go. The early reasonings of children are peculiarly interesting and amusing, especially in their quest for causes. Mr. Brown's report of recorded cases, compiled at the Worcester Normal School, comprises examples of all shades of this kind of reasoning. Here is a contribution made from an observation of a five-year-old child: "Jennie said: 'What makes people sleepy?' Hilda replied: 'These little hairs on your eyelids. Every time they come against your eye they make you sleepy.'" Another good example is that of the seven-year-old boy who, when asked why he liked apple pie, replied: "I guess it's because I like the bottom crust, and the upper crust, and the apples." What could be more realistic than the following conversation of two boys? The lawn had been sown to grass, and the little green shoots were just visible.

First boy: "See how the grass grows."

Second boy: "What makes it grow?"

First boy: "God does."

Second boy: "No, he don't. It's the manure they put on the ground."

I remember of once observing a little three-year-old who was a member of a pleasure party rowing on the river. One of the oarlocks gave forth an unpleasant squeak, and little Ted was told to po [illegible] ater on the rusty oar-lock, which he did, putting a [illegible] ıpleasant noise. The next day he saw some guinea [illegible] cle's barnyard, and noticing the peculiar noise they made, he rushed into the house for his tin cup, because he wanted to give the guineas some water "to make their necks stop squeaking."

No better instances of the natural impulse to search for a reason for things are to be found than those examples that grow out of thoughts about God and his relation to the world. Thus six-year-old M. thought rain was caused by God pulling a string, just as she did for a shower-bath.

"God is a big, perhaps blue man, very often seen in the sky, or in the clouds, in the church, or even street. He came in our gate, comes to see us sometimes. He lives in a big palace or in a big brick or stone house on the sky. He makes lamps, babies, dogs, trees, money, etc., and the angels work for him. He lights the stars so he can see to go on the sidewalk or into the church. Birds, children, Santa Claus, live with him, and most, but not all, like him better than they do the latter. When people die they just go, or are put in a hole, or a box or a black wagon that goes to heaven, or they fly up or are drawn or slung up into the sky, where God catches them. They never get out of the hole, and yet all good people somehow get where God is. He lifts them up, they go up on a ladder or rope, or they carry them up, but keep their eyes shut so they do not know the way, or they are shoved up through a hole. When children get there they have candy, rocking-horses, and everything in the toy-shop or picture-book; play marbles, top, ball, cards, hookey, hear brass bands, have nice clothes, gold watches, and pets, ice cream and soda water, and no school. There are men who died in the war made into angels, and dolls with broken heads go there. . . . The bad place is like an oven or a police-station where it burns, yet is all dark, and folks want to get back, and God kills people or beats them with a cane. God makes babies in heaven, though the holy mother, and even Santa Claus, makes some. He lets them down or drops them, and the women or doctors catch them, or he leaves them on the sidewalk, or brings them down a wooden ladder backwards and pulls it up again, or mamma or the doctor or the nurse go up and fetch them sometimes in a balloon, or they fly down and lose off their wings in some place or other and forget it, or jump down to Jesus, who gives them around."*

That these analogies, which lie at the basis of much of our reasoning, are detected quite early, is illustrated in the case of the child one year and eight months old, a little girl, who had a doll whose hair had all come off. After visiting her grandpa (who happened to be bald-headed), she named her doll "Grandpa."

We all know that careful research with a view to the discovery of causes is apt to be a very tedious process. It always implies a painstaking, systematic method of procedure, as is evidenced by all forms of worthy scientific investigation.

There are, generally speaking, two ways in which we, as well as men of science, gain knowledge of the world about us. The first way, as Jevons so aptly puts it, is merely *to observe what happens without any interference on our part.* We notice the rise and fall of the tide as we stroll along the beach. If we become sufficiently interested, we can set down on paper the times at which the tide is highest on several days in succession; we shall learn that high tide occurs about three-quarters of an hour later on each day than on the previous day. If we notice the heights of the tides still more closely, we observe that they are greatest at the time of the new and full moon. In such phenomena as these we cannot in any way interfere, govern or regulate the things we observe.

The changes of the weather, the occurrence of storms, earthquakes, meteoric showers, volcanoes, the rotation of the earth, the revolution of the planets, and the like, are all things that are beyond our interference and control. In our investigations into such things, we are able to employ only *simple observation.*

But there is possible a condition of things in which we can, in a measure, manage the circumstances; that is, we can *make experiments.* This means that, whenever possible, we should put

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[illegible] G. Stanley Hall's paraphrase of children's actual sayings, ex- [illegible] of their crude reasonings. See "The Pedagogical Seminary," together things, of which we wish to learn the nature and their manner of behavior under different circumstances, in such a way as to exhibit what the action will be under certain known circumstances. *In experiment we interfere with things by interposing new conditions; we then observe the results.* Experimentation is observation *plus* something else, namely, the regulation and control of things whose nature and behavior we are seeking to observe.

Experiment possesses, as you can readily see, considerable advantage over mere observation, especially in scientific research. The knowledge we gain by experiment is more accurate because we know more clearly and definitely the exact cause of the phenomena with which we are dealing, than we do in the simple observation of natural events. The causes of the events in the experiments we conduct, are determined by our own will in regard to the matter and we can know them more certainly; while, on the other hand, in the mere observation of occurrences taking place in nature and beyond our control, we cannot be at all certain that such and such an effect is produced by such and such a cause.

Furthermore, in experimentation, when we control the course of events, we are enabled to discover entirely new substances and to learn their properties. We vary the conditions and find that certain modifications are brought about by such variation. You can illustrate the point for yourself by carrying on some of the simplest of the ordinary experiments in physics or chemistry, put down in our text books.

There are at least four different steps or stadia in all indicative reasoning. These are:

First step.— Preliminary observation.

Second step.— The making of hypotheses.

Third step.— Deductive reasoning.

Fourth step.— Verification.

The knowledge gained by the first step is such as comes through the senses in simple observation. In taking the second step, we proceed to reason about these facts and make a scientific guess [hypothesis] concerning their probable cause. In the third step, we are merely occupied in reflecting upon what particular facts (at yet unobserved), will be true if our hypothesis should prove, by subsequent investigation, to be true. In the fourth and final stage of procedure, we seek to determine whether our hypothesis can be verified by reference to actual occurrences in the world about us, or at least within the domain to which the class of phenomena we are investigating belongs. Jevons illustrates this well by reference to the method of procedure followed in establishing the Law of Gravitation.

"Probably the most important law of nature ever discovered is that called the Law of Gravity, which states that all bodies in space tend to fall towards each other, with a certain force depending upon the magnitudes of the bodies and the distance between them. It might seem that we need no aid of logic to show us that things fall towards the earth, because, whether we throw up a stone or a book, a gold coin or a feather, they will all descend more or less quickly to the surface of the earth. The ancient Greeks observed this much, and no doubt the ancient Egyptians and other peoples before them. But then it does not seem to be true that all bodies fall; for flames ascend upwards, and in smoke, and clouds, and bubbles we have other exceptions. Aristotle, the greatest of Greek philosophers, came to the conclusion that some things were naturally heavy and tended to fall, while other things were naturally light, and tended to rise. Only about two hundred years ago did Newton succeed in showing how much better it was to make the hypothesis that all things tend to fall, because he could then explain not only the motions of flame and other apparently light things, but also the movements of the moon, sun and planets. If we put a pound weight into one scale of a balance, and only half a pound into the other scale, the latter will of course go up as the former is pulled down by the greater force. So, if flame be a lighter substance than the air around, it will be forced or buoyed up like a cork in water. Thus, when we argue deductively, we find that what is apparently tending to rise up- [illegible] may really be tending to fall downwards, but is over- [illegible]d by the greater tendency of other bodies.

"Newton argued again in this way: If all bodies tend to fall towards each other, all bodies ought to fall towards the earth. Now the moon is a body, and therefore it ought, according to evident reasoning in the manner of the syllogism, to fall towards the earth. Why does it not do so, instead of revolving round the earth once in every lunar month? It occurred to him that, if the moon were not in some way held by the earth, it ought to go off flying away in a straight line, like a stone from a rapidly revolving sling. A moving body will move in a straight line unless some force obliges it to alter its course. Thus it appeared likely that in reality the moon was always falling towards the earth, and that it was this constant falling which prevented it from moving off in a straight line. Newton then proceeded to prove by most ingenious mathematical reasoning that the force of gravity, if it were such as he supposed it to be, would keep the moon constantly moving round the earth. He also showed that, if his hypothesis of gravity were true, the planets would move round the sun as they do. He went on to explain a great many peculiarities in the motions of the planets and their satellites. He showed that even comets, though they come and go in so apparently irregular a manner, really move in long orbits, as gravity would make them move. The tides, too, are another peculiar effect of the same force. Thus his law became a *verified hypothesis*, one so entirely agreeing with facts that we cannot but believe it to be correct. It becomes an established law of nature, and is sometimes called a theory; but this last word, theory, is used with several different meanings, and we should take care not to be misled by it. Here it means only a well-verified hypothesis."

It ought to be easy to see that deductive reasoning alone will never teach us anything new, because it only gives us one proposition, when we already have others from which this one is derived. How then are we to get the original propositions? This must be done by using our eyes, ears, and other sense organs and observing things about us, so as to learn what they really are. This seems to be evidently the proper way to get k [illegible] nd we may well wonder that people ever thought differently. Nevertheless, for many centuries it was believed to be possible to arrive at all necessary knowledge by the use of the syllogism, and men preferred trusting to Aristotle, rather than using their own eyes. It used to be said that God made men two-legged, and Aristotle made them rational.

The rise of modern science may, perhaps, "be considered to date as far back as the time of Roger Bacon, the wonderful monk and philosopher of Oxford, who lived between the years 1214 and 1292. He was probably the first in the middle ages to assert that we must learn science by observing and experimenting on the things around us, and he himself made many remarkable discoveries. Galileo, however, who lived more than 300 years later (1564 to 1642), was the greatest of several great men, who in Italy, France, Germany, or England, began by degrees to show how many important truths could be discovered by well-directed observation. Before the time of Galileo, learned men believed that large bodies fell more rapidly towards the earth than small ones, *because Aristotle said so.* But Galileo, going to the top of the Leaning Tower of Pisa, let fall two unequal stones, and proved to some friends, whom he had brought there to see his experiment, that Aristotle was in error." *It is Galileo's spirit of going direct to nature, and verifying our opinions and theories by experiment,* that has led to all the great discoveries of modern science. And this is the spirit that should be inculcated into the students of to-day. Some so-called scientists must have the particular object they are called upon to examine, soaked in paraffine, sliced with a microtome and boiled in corrosive sublimate, before they examine it. What is actually needed is a band of men who are thoroughly enthusiastic as scientists, and eager to roam over fields and through the woods to study objects and organisms in their natural setting and environment.

By such inductive methods as those already instanced, the child [illegible]ly reaches a large amount of general knowledge. [illegible]ge embraces the results of his observation of things; [illegible] certain events in nature; just what his own and other human actions can accomplish, and of analogies and dissimilarities. As in all other lines of progress, he is exceedingly dependent upon his elders, his parents and teachers, who give him instruction, and sometimes he goes so far as to derive all of his general knowledge, at least in the initial stages, from what others tell him.

Now, when the child has gotten together a fund of general knowledge, whether gained by his own observation, or from instruction by others makes no great difference, he is ready to pass on to the second stage of explicit reasoning, known as deduction. You remember that by induction is meant the process of reasoning upward from particular facts to a general truth or principle. Now, deduction, on the other hand, is the process of reasoning downward from a general truth to some particular concrete case. Thus a child whose mind has been fed on some of the "goody-goody" books which tell him of scores of boys who were drowned by going boating on Sunday, or of a number who had their arms broken while stealing apples, is liable to regard it as a general rule that all boys who go boating on Sunday will be drowned, or that all boys who steal apples will have an arm broken. These general principles he reaches by a process of induction. When he comes to apply this general principle to himself, and says, "If I go boating on Sunday, I shall be drowned," he makes use of deductive reasoning. He notices that his dog suffers pain, and is told that all animals suffer pain, so he concludes, as a result of deduction from this general statement, that the cow, horse, or sheep suffers pain. The form of deductive reasoning, when fully expressed—when made explicit in terms of language—furnishes us what is known in logic as the syllogism. Thus:

All animals die.
My dog "Jip" is an animal.
Therefore my dog "Jip" will

This is called an affirmative syllogis
sitions are affirmative judgments lead
clusion.

As an example of a negative syllogism we have:

> No horse eats meat.
> "Prince" is a horse.
> Therefore, "Prince" does not eat meat.

For here we reach a negative conclusion. The essential process here, in both syllogisms, as in induction, is detecting similarity or analogy. We bring the particular case of the dog "Jip" under the general rule or principle that "animals die," and we do this because we detect similarity and identity between "Jip" and other animals, for the particular case must obey the behests of reason and come under the general rule. The same holds good in the negative syllogism. We bring the particular case of the horse "Prince" under the general rule "No horse eats meat," because we know that "Prince" is like other horses, or better, is identical with other horses in his main characteristics. He must be like other horses in respect to certain of the more important attributes, in order to be a horse.

Now, the detection of similarity, analogy and identity is the essential process in deductive reasoning, as it is in the inductive form. Yet it must also be remembered that discrimination plays an important part. Especially in those arguments where we reach negative conclusions, are we engaged in this work of discriminating among the various marks, characteristics and qualities that are presented. Thus when I argue:

> Only sound horses can run fast.
> This horse is lame (or unsound).
> Therefore, this horse cannot run fast,

I am making use of certain powers of discrimination in separating a particular horse from a general class of horses.

The process of deduction may lead to a valid or invalid conclusion: that the conclusion may be valid the processes of deduct[illegible] regulated. It is the business of formal logic to [illegible]e requirements that must be satisfied in order to [illegible] valid reasoning.

Errors and mistakes in reasoning are called fallacies, that is, modes of reasoning which deceive. But we ought not to confuse a false opinion with the bad reasoning by which it is reached. The word fallacy is, in fact, an ambiguous one. In one sense it is a fallacy to say that the moon governs the weather, because long and careful inquiries have shown that there is no correspondence between the changes of the moon and the changes of the weather. But this is a fallacious or false opinion; the logical fallacy consists in the bad reasoning which has by degrees led people to believe in the moon's power. On one or two occasions a person may notice a change of weather on the day of new moon, and he thinks it so singular that he tells his neighbors of the fact, and they remember perhaps to have noticed the same thing once or twice. But it is bad reasoning to argue that, because on a few occasions things happen one after the other, therefore the one is the cause of the other.

But before indicating the usual sources of fallacious reasoning, it might be well to call attention to the fact that in ordinary practical reasoning the processes are seldom formally expressed in the language of full and complete syllogisms. Indeed, there are exceedingly few persons who can detect the syllogistic process in their ordinary chains of reasoning. Locke's estimate of the practical utility of the syllogism is well worth quoting here. It is selected from his famous "Essay on the Human Understanding."

"Of what use, then, are syllogisms? I answer, their main and chief use is in the schools, where men are allowed without shame to deny the agreement of ideas that do manifestly agree; or out of the schools, to those who from hence have learned without shame to deny the connection of ideas, which even to themselves is visible. But to an ingenuous searcher after truth, who has no other aim but to find it, there is no need of any such form to force the allowing of the inference; the truth and reasonableness of it is better seen in ranging of [illegible]nd plain order; and hence it is that [illegible]h, never use syllogisms to [illegible] others to instruct willing learners). . . . But if men skilled in and used to syllogisms, find them assisting to their reason in the discovery of truth, I think they ought to make use of them. All that I aim at, is, that they should not ascribe more to these forms than belongs to them, and think that men have no use, or not so full a use, of their reasoning faculties without them. Some eyes want spectacles to see things clearly and distinctly; but let not those that use them therefore say nobody can see clearly without them; those who do so will be thought in favor of art (which, perhaps, they are beholden to), a little too much to depress and discredit nature. Reason, by its own penetration, where it is strong and exercised, usually sees quicker and clearer without the syllogism. If use of those spectacles has so dimmed its sight, that it cannot without them see consequences or inconsequences in argumentation, I am not so unreasonable as to be against the using them. Every one knows what bests fits his own sight; but let him not thence conclude all in the dark, who use not just the same helps that he finds a need of."

Without going into the minute details of logical fallacy, we may indicate certain general causes of defective reasoning and erroneous deduction. We have emphasized the fact that reasoning consists chiefly in a detection of similarity and identity. If this is true, then it is not difficult to see that the great source of invalid deduction lies in a sort of mental confusion in which things that are actually similar are not so regarded, while those that are essentially unlike are conceived to be similar—there is a lack of discriminative ability. The erroneous reasoner does not see where similarity leaves off and difference begins. Children are extremely liable to this error, because their intense eagerness to find a reason for a fact, a cause or explanation for an event, may precipitate them at once into such an intellectual confusion that loose reasoning cannot fail to result.

Perhaps the most common sort of error in deductive argument i [illegible]guity of terms, for in such a case the mind fails to [illegible] rious shades of meaning that can belong to the same [illegible]:

No designing person ought to be trusted.
The architect is a designer.
Therefore architects ought not be trusted.

In this bald case it is easy enough to detect the source of the fallacy. But there are instances where the ambiguity is more subtle, and requires a keener logical insight for its detection. The reasoner must always be on the alert for the ambiguous use of terms, and no source of confusion is more fruitful of error than the simplest words and language that are ambiguous in their meaning.

A word with two distinct meanings is really two words. If a person were to argue that his ailment is a cold, and that all cold is dispelled by heat, it would be absurd thus to confuse together a cold or catarrh with the absence of heat. But in many cases it is by no means easy to see that we are using the same word with two meanings.

Take such common words as chair, bill, table, paper and ball, and seek out the many different meanings that can be assigned to each one. If you do this carefully you will quite readily see how it is that ambiguity can easily become a source of error in reasoning. To take the old illustrations of Jevons:

"Changes of the meaning of words are usually effected by no particular person and with no distinct purpose, but by a sort of unconscious instinct in a number of persons using the name. In the language of science, however, changes are often made purposely, and with a clear apprehension of the generalization implied. Thus soap in ordinary life is applied only to a compound of soda or potash with fat, but chemists have purposely extended the name so as to include any compound of a metallic salt with a fatty substance. Accordingly there are such things as *lime-soap* and *lead-soap*, which latter is employed in making common diachylon plaster. (He might have added to this li [illegible] ' as used by the political heeler.) Alcohol at first deno [illegible] of ordinary fermentation commonly ca [illegible] chemists having discovered that ma [illegible] *theoretical composition* closely rese [illegible] name was adopted for the whole class, and a long enumeration of different kinds of alcohol will be found in Dr. Roscoe's "Lessons on Chemistry." The number of known alcohols is likewise subject to indefinite increase by the progress of discovery. Every one of the chemical terms, acid, alkali, metal, alloy, earth, ether, oil, gas, salt, may be shown to have undergone great generalizations.

"In other sciences there is hardly a less supply of instances. A lens originally meant a lenticular-shaped or double convex piece of glass, that being the kind of glass most frequently used by opticians. But as glasses of other shapes came to be used along with lenses, the name was extended to concave or even to perfectly flat pieces of glass. The words lever, plane, cone, cylinder, arc, conic section, curve, prism, magnet, pendulum, ray, light, and many others, have been similarly generalized.

"In common language we may observe that even proper or singular names are often generalized, as when in the time of Cicero a good actor was called a Roscius, after an actor of pre-eminent talent. The name Cæsar was adopted by the successor of Julius Cæsar as an official name of the emperor, with which it gradually became synonymous, so that in the present day the kaisers of Germany and Austria and the czars of Russia, both take their title from Cæsar. The celebrated tower built by the king of Egypt on the island of Pharos, at the entrance of the harbor of Alexandria, has caused lighthouses to be called *phares* in French, and *pharos* in obsolete English. From the celebrated Roman general, Quintus Fabius Maximus, any one who avoids bringing a contest to a crisis is said to pursue a Fabian policy.

"The word *foot* has suffered several curious but very evident transfers of meaning. Originally it denoted the foot of a man or an animal, and is probably connected in a remote manner with the Latin *pes, pedis;* but since the length of the foot is naturally employed as a rude measure of length, it came to be applied to a fi[illegible]asure of length; and as the foot is at the bottom of the [illegible]name was extended by analogy to the foot of a moun-[illegible]e foot of a table; by a further extension, any position, plan, reason, or argument on which we place ourselves and rely, is called the foot or footing. The same word also denotes soldiers who fight on their feet, or infantry, and the measured part of a verse having a definite length. That these very different meanings are naturally connected with the original meaning is evident from the fact that the Latin and Greek words for foot are subject to exactly similar series of ambiguities.

"It would be a long task to trace out completely the various and often contradictory meanings of the word *fellow*. Originally a fellow was what *follows* another, that is, a companion; thus it came to mean the other of a pair, as one shoe is the fellow of the other, or simply an equal, as when we say that Shakespeare 'hath not a fellow.' From the simple meaning of companion, again it comes to denote vaguely a person, as in the question, 'What *fellow* is that?' but then there is a curious confusion of depreciatory and endearing power in the word; when a man is called a *mere fellow*, or simply a *fellow* in a particular tone of voice, the name is one of severe contempt; alter the tone of the voice of the connected words in the least degree, and it becomes one of the most sweet and endearing appellations, as when we speak of a dear or good fellow. We may still add the technical meanings of the name, as applied in the case of a Fellow of a college or of a learned society.

"Another good instance of the growth of a number of different meanings from a single root is found in the word *post*. Originally a post was something *posited*, or placed firmly in the ground, such as an upright piece of wood or stone; such meaning still remains in the cases of a lamp-post, a gate-post, signal-post, etc. As a post would often be used to mark a fixed spot of ground (e.g., a mile-post), it came to mean the fixed or appointed place where the post was placed, as in a military post, the post of danger, the post of honor, etc. The fixed places where horses were kept in readiness to facilitate rapid traveling, as in the times of th Roman empire, were thus called posts, and thence the whole sy tem of arrangement for the conveyance of persons or to be called *the posts*. The name has retained an exa meaning to the present day in most parts of Europe, and we still use it in post-chaise, post-boy, post-horse, and postilion. A system of post conveyance for letters having been organized for about two centuries in England and other countries, this is perhaps the meaning most closely associated with the word post at present, and a number of expressions have arisen, such as post office, postage, postal guide, postman, postmaster, postal telegraph, etc. Curiously enough, we now have iron letter-posts, in which the word post is restored exactly to its original meaning."

That misuse of words is the great cause of error in our thinking, was well expressed by Locke over two hundred years ago:

"For he that shall well consider the errors and obscurity, the mistakes and confusion that are spread in the world by an ill use of words, will find some reason to doubt whether language, as it has been employed, has contributed more to the improvement or hindrance of knowledge amongst mankind. How many are there, that, when they would think on things, fix their thoughts only on words, especially when they would apply their minds to moral matters; and who, then, can wonder if the result of such contemplations and reasonings about little more than sounds, whilst the ideas they annex to them, are very confused and unsteady, or perhaps none at all—who can wonder, I say, that such thoughts and reasonings end in nothing but obscurity and mistake, without any clear judgment or knowledge?"

It is an easy matter, then, to perceive the necessity of regulating the reasoning power in its procedure from the known to the unknown, its search after explanations and sufficient reasons for all that occurs and exists. This regulation of the processes of reasoning must come chiefly under the guidance and stimulation of others. The function of the teacher in this connection is an exceedingly important one, yet an extremely difficult one to serve.

In the earliest stages of the child's development, parents are called upon to answer many questions prompted by the child's curiosity and desire for explanation. Do parents and teachers what a momentous period this is for the child? Children are so capricious in their questionings that we are apt to think their inquiries, as to the why and how of things, are made from force of habit, or are put in a half-mechanical sort of way without any real desire for information. There is no saying more true than the one to the effect that children and fools can ask questions which wise men cannot answer. But it is erroneous to think that children's questions are purposeless, or put for the mere sake of teasing parents or teacher, though this may sometimes seem to be the case. Once when my vacation was drawing to a close, a little fellow of four observed me packing my valise as I was preparing for the journey back to college, and the following conversation took place:

Question. "What are you packing your valise for?"

Answer. "Because I am going away."

Q. "What are you going away for?"

A. "Oh, to get to work."

Q. "Well, what do you want to get to work for?"

A. "To earn money."

Q. "Well, what do you want to earn money for?"

A. "To get through the world."

Q. "What do you want to get through the world for?"

Under such circumstances it is rather hard to follow Locke's advice when he says:

"Encourage the child's inquisitiveness all you can by satisfying his demands and informing his judgment as far as possible." Yet all of us, in spite of some tantalizing and trying experiences, believe that a good rule to follow is to give an explanation whenever the nature of the subject will permit such an explanation in simple, clear and lucid form. And when we come to think of children as capricious in their questioning and are overwrought by the tantalizing and irrepressible "Why," let us remember that their horizon is exceedingly limited, so limited that they are constantly chafing on account of it. Furthermore, we must remember that one of the chief ways of extending this horizon is to furnish the child information in response to his eager, impulsive and instinctive "Why."

And again, we all know that the child demands, and naturally and rightfully too, the intellectual sympathy of his elders. It is only in manhood, when there are no longer teachers at hand, that the observations and inferences required for early guidance are expected to be made without assistance. In the constant but none the less sincere "Why" of the child, nature is perpetually thrusting the true method of education upon us.

However, a word of caution is not entirely out of place. We must be careful not to indulge children too much in the way of questioning—that is, we should be careful to avoid promoting a sort of intellectual laziness, and at the same time avoid making them entirely dependent upon others. It is, as we have previously stated, far better to show a child the route which leads to the correct answer of his question, than to *tell* him the answer outright, if the route be not a complicated one, and the desired destination not removed too great a distance from the child's present point of view. As Herbert Spencer has said: "To *tell* a child this or that, is not to teach him how to observe, but simply to make him the recipient of another's observations . . . depriving him of the pleasures that result from successful activity."

But early training of the reasoning powers involves much more than the mere answering of the simple, spontaneous questions of children. Not only may the child question you, but *you must question the child* as to the reasons of things, and the causes of what he sees happening in the world about him. A question sets the child to observe more closely, and each new item gained by observation is so much new food for reflection. So by your query as to the cause of a certain phenomenon, you stimulate his reasoning powers by raising new problems within his mind. I think the most interesting lesson I ever received with reference to the different densities of the various liquids grew out of a thoughtful teacher's question. It was this, "Why does beer *foam* and wine *sparkle?*"

Furthermore, do you not see that by asking *the why of things* you are continually impressing upon the mind of the child the *principle* that every event, every occurrence, has its cause and its explanation. As parent or teacher it is your privilege, yes, your *duty*, to fix a habit of inquiry in the child's mind, by continually calling his attention to certain phenomena as they take place, and encouraging him to find out the causes, in so far as is possible, by appeal to his own mental capital and powers of observation. Don't raise queries that have no touch or point of intimate contact with his every-day experiences. You know all that is meant by the phrase "to explain" is the bringing of some unknown fact or effect under some known class of experiences. Children tend to do this continually. They are ever going back to their past experiences in their quest for analogies that apply to the case under consideration. This is especially seen in the names children give to new objects.

My own little girl (five years old) has insisted upon calling the midvein of a leaf its "spinal cord," ever since I showed her the spinal cord of a cat (*in situ*) when she was in my laboratory six months or more ago. Certain savages are said to have called horses big dogs, on seeing them for the first time, because they were more like dogs than anything they had ever seen.

By systematic training, then, and systematic training only, can the reasoning powers be developed in a proper manner, and the mind of the child prevented from falling into such fallacious reasoning as was instanced earlier in the chapter. Do your best to prevent too hasty inductions on the part of the child; do not permit him to take certain accidental features as essential characteristics of an object. For example, do not let him insist that all apples are red because the one he is now eating happens to be of that color—make it perfectly plain to him that the color of the apple is purely an *accidental* feature and not an essential characteristic.

For the main source of error in inductive reasoning (and most of our reasoning belongs to this class), lies in the fact that we make our inductions too hastily. And in deductive reasoning, make it plain to the young mind just what cases do come under the general rule he has discovered, and what cases do not.

But now comes the most important question of all that have been raised and discussed in this chapter. *What subjects or studies best exercise the pupil's reasoning powers?* You cannot assign young children, or even high school pupils, lessons in formal logic. And even if the child could comprehend the full import of all the rules of logic that have been devised since the time of Aristotle, he would not of necessity be a good reasoner, any more than the person who reads the best book on athletic training could develop his muscles while simply languishing in a "Sleepy Hollow" chair. To learn even to "skin the cat," one must engage in physical exercise; he must also indulge in a set of routine exercises to develop his arms different from the one employed to develop his chest. So in mental training. The powers of mind are developed through exercise. Now the question is: *What special routine of study is it best to employ, in order to so exercise the mind of the child that its reasoning powers will be best furthered in their path of development?*

The mother and kindergarten teacher can do much in influencing the direction of the child's questionings, thus training his reasoning powers. But the continued education of this reasoning faculty is the problem of the teacher in the common school. Of course all studies, in the hands of the skillful, keen, wide-awake teacher, will be made to contribute something toward bringing about this rational development. Yet there are subjects, the study of which is especially suited to stimulate the reasoning faculty, and guide it into the best possible manifestations of its activity.

One of the best studies for this purpose is physical geography. In the study of physical geography the child comes into actual contact with natural phenomena; and for countless reasons the study of physical geography ought come *before* the study of political or descriptive geography. In the study of physical geography, the child exercises his mind in reasoning about the causes of natural phenomena. Better acquaint the child with the real explanation of the hillside spring, that bubbles forth f [illegible] nd, or inform him as to the principle that underlies [illegible] of the artesian well, or let him know the causes of [illegible] —much better and much more natural is this food for the child's mind (because more easily assimilated), than all you can cram into him concerning monarchy, duchy, republic, dukedom, boundary lines, and the like.

If history be well taught, it will also be a mighty lever in raising the child in the scale of knowledge and in developing his powers of reasoning.

For historical study, properly conducted, develops the child's power of tracing analogies, of reasoning as to the causes and effects of human action, and deducing certain general principles that govern men in their national life. But sad to say, most history is poorly taught. We regret that what Mr. Spencer says with regard to the worthlessness of ordinary history is so true. We here reproduce what he says, in the hope that it will help some of us to modify our courses in history accordingly:

"But, as already more than once hinted, the historic information commonly given is almost valueless for purposes of guidance. Scarcely any of the facts set down in our school histories, and very few even of those contained in the more elaborate works written for adults, give any clue to the right principles of political action. The biographies of monarchs (and our children commonly learn little else) throw scarcely any light upon the science of society. Familiarity with court intrigues, plots, usurpations, or the like, and with all the personalities accompanying them, aids very little in elucidating the principles upon which national welfare depends. We read of some squabble for power, that it led to a pitched battle; that such and such were the names of the generals and their leading subordinates; that they each had so many thousand infantry and cavalry, and so many cannon; that they arranged their forces in this or that order; that they maneuvered, attacked, and fell back in certain ways; that at this part of the day such disasters were sustained, and at that, such advantages gained; that in one particular [illegible] some leading officer fell, while in another a certain [illegible]; that after all the changing fortunes o [illegible] gained by this or that army, [illegible] wounded on each side, and s [illegible]

. . . That which constitutes history, properly so called, is in great part omitted from works on the subject. Only of late years have historians commenced giving us, in any considerable quantity, the truly valuable information. As in past ages the king was everything and the people nothing, so in past histories the doings of the king fill the entire picture, to which the national life forms but an obscure background. While only now, when the welfare of nations rather than of rulers is becoming the dominant idea, are historians beginning to occupy themselves with the phenomena of social progress. That which it really concerns us to know, is the natural history of society."

But above and beyond all other subjects in real value as an agency to promote the development and correct activity of the reasoning powers, there is nothing like the study of the natural sciences, be it botany, zoölogy, geology, physiology or what. Any natural science study serves to stimulate the reasoning powers into exercise, at the same time developing and strengthening them, and, what is still better, guiding them into correct modes of activity. Science is "knowledge systematized," and a study of science tends to make one more systematic and correct in his thinking. Science is knowledge in its most precise form of expression, and students of science strive harder and harder to make their thinking more precise that their conclusions may also be more exact. Each of the sciences sets out with observation and experiment, by means of which it hopes to establish certain general principles that hold true within the domain of that particular science. Then it proceeds to seek out all the phenomena and occurrences that come under the scope of this general principle and applies these established principles to all the particular facts deductively. Science trains the reasoning powers into an orderly, systematic and precise manner of activity. The boy who comes to school with a garter-snake in his pocket (even if he bring it to frighten the girls), the one who gathers specimens of butterflies, bugs and beetles, the one who tears his clothes in cl[illegible]es for birds' nests, or the one who wears out the linings [illegible]s with a collection of arrowheads he has found—any and all of these boys are a long distance ahead of the boy who is compelled to bound Australia, or extract the square root of the largest series of numbers ever put between the covers of an arithmetic.

Science lessons can be given in a most interesting manner. For the first lessons nothing better is needed, as a guide on which they may base their own observations, than a good edition of "Robinson Crusoe." In this interesting tale the child learns of a man's struggles with the elements and forces of nature. The child is thus brought face to face with nature in the interesting story of the life of this one man. The methods this hermit employed to protect himself from nature's forces, the means used by him to prepare his food, can and will be compared by the child himself with his own experiences and environment. The habitation of Crusoe will be compared with his own home; the crude cooking utensils of the hermit are compared with those which the child's own mother makes use of in the family kitchen; the clothing of Crusoe is compared with the child's own or that of his father. What better model of inductive reasoning can the child follow than that employed by this lonely hermit when he discovers the track on the shore sands of his island home? By taking up this interesting tale you touch the child's life on every side; you acquaint him with some of the greatest truths of modern science, and you at the same time stimulate his powers of reasoning to exercise themselves in the most precise and methodical way, and in a manner to strengthen and develop them most fully and satisfactorily. The natural sciences "*provide the best training of the mind in the patient, accurate investigation of facts, and the cautious building up of general truths, on the firm basis of actual observation.*"

With reference to deductive reasoning, it is most probably true, that geometry contributes the most in the way of development of one's latent reasoning power. At least [illegible]f geometry Professor Wyse insists upon, would acc[illegible] in this direction. Here is his own statement:

"A child has been in the habit of using [illegible] let him also use them for the elements of geometry. I would begin with solids, the reverse of the usual plan. It saves all the difficulty of absurd definitions, and bad explanations on points, lines and surfaces, *which are nothing but abstractions.* . . . A cube presents many of the principal elements of geometry; it at once exhibits points, straight lines, parallel lines, angles, parallelograms, etc. These cubes are divisible into various parts. The pupil has already been familiarized with such divisions in numeration, and he now proceeds to a comparison of their several parts, and of the relation of these parts to each other. . . . From thence he advances to globes, which furnish him with elementary notions of the circle, and of curves generally.

"Being tolerably familiar with solids, he may substitute planes. The transition may be made very easy. Let the cube, for instance, be cut into thin divisions, and placed on paper; he will then see as many plane rectangles as he has divisions; so with all the others. Globes may be treated in the same manner; he will thus see how surfaces really are generated, and be enabled to abstract them with facility in every solid.

"He has thus acquired the alphabet and reading of geometry. He now proceeds to write it. The simplest operation, and therefore the first, is merely to place these planes on a piece of paper, and pass a pencil around them. When this has been frequently done, the plane may be put at a little distance, and the child required to copy it, and so on."

Passing from this empirical geometry to the Euclidean, as set forth in the average text-book on that subject, we find that the process of demonstration here employed, which shows how certain conclusions necessarily follow from certain established principles, is an exercise of the logical faculty that is of peculiar and inestimable value. To that process of reasoning which leads the pupil gradually and understandingly from the statement of a theorem through the various meshes and shades of argument [illegible] "Q. E. D." is reached, must be awarded the palm for the [illegible]pline of the powers of deductive reasoning.

LESSON XXIII.

DEVELOPMENT OF THE WILL.

No subject in connection with child-study is more difficult to treat than that which is ordinarily indicated by the term volition. Neither can you find a subject more important, for the true understanding of the evolution of the will power is necessary in order to become at all thoroughly acquainted with the more purely intellectual and moral ideas.

Activity is a fundamental property of the conscious life, and if any one of the elements of consciousness — feeling, knowing, willing — is to be regarded as the original form of the conscious life, (the primordial element of consciousness) it must manifestly be the will. The manifestations of the intellect and feeling acquire the fullest significance only when they serve as links in the chain that leads to *action*. Of course the first arousement of the conscious life begins with sensation. When the first sensation has been experienced, the psychical processes are set a-going. Without education of the child's will it is next to impossible to improve his mental, moral, or physical well-being in any respect.

The question we must really answer in this chapter is, "How has this element (the element of motor innervation) been added to the sentient life of the animal?" This leads us to impress the fact that a distinction must be made between will in its narrower and in its wider application. In the more restricted use of the term, as commonly employed in ethics for example, will is made to mean the power of choosing between different possible lines of action or conduct. In this sense the will is only the *product* of mental development and in no sense an original factor
But if will be understood in the broader sense, it will be foun
comprehend all forms of activity, whether determined by

or remembered images, and taken in this wide application, will must be regarded as the fullest expression of the conscious life, even from the very first beginnings of this conscious life. When we so conceive of the will, in these two aspects or significations, we can readily see that the development of will in the person, proceeds from will in the wider sense to will in the more restricted sense. This development is not necessarily a steady progression. It is more frequently sporadic, and at times very one-sided, turned hither and thither by opposing circumstances; but if this development attains its fullest fruition we find, as the final outcome, the individual will leading from these opposing impulses to a deep inner harmony of the entire mental life.

To employ the figure of Professor Höffding, we may then say that, as in Greek mythology Eros was made one of the oldest and at the same time one of the youngest of the gods, so in Psychology the will may, according to the point of view we take, be represented as the most primitive, or as the most complex and derivative of the mental products. If by will we mean only that power which manifests itself in action from deliberate choice alone, then we must maintain that there has already been a rather extensive development in the individual's mental life, for such will acts as here signified, cannot exist in the lowest forms of the sentient consciousness. To understand the true nature of will, it is absolutely necessary to go back to the primitive germ, and to trace it in its path of development from the unconscious to the conscious — from the most purely involuntary movements to those that are more refined and intricate as examples of deliberative choice.

Preyer was among the first to seek to account for the development of will in the child, and seems to regard it as the natural outcome of the desire the child has for everything that has once occasioned pleasurable sensations. On *a priori*, rather than on experimental grounds, Preyer maintains that the will is called into life by the union of two factors, (*a*), an end or pleasure desired; (*b*), the movement necessary in order to attain this desired end. He places most emphasis upon the first of these two factors, because the movements can in a large measure be dispensed with, in the more highly developed forms of the conscious life.

Perez tells us: "The will is born little by little from reflex impulsive movements, which with the progressive unfolding of the faculties of perception and ideation, and after having been for a long time carried out and modified in various forms of activity, pass into the domain of the attention and become conscious or voluntary actions." Professor James regards the purely voluntary movements as secondary functions of our organism, while "reflex, instinctive, and emotional, are all primary performances." With him, and we think quite properly, too, the voluntary movements depend upon the remembered images of former involuntary ones. To quote directly: "When a given, particular movement having once occurred in a random, reflex, or involuntary way, has left an image of itself in the memory, *then the movement can be desired again, proposed as an end and deliberately willed.* But it is impossible to see how it could have been willed before. A supply of ideas of the various movements that are possible, left in the memory by experiences of their involuntary performance, is thus the first pre-requisite of the voluntary life."

It is easy to see from the above, that representative psychologists regard the earliest movements of the child as not voluntary, but, on the other hand, only reflex, instinctive, and impulsive. In the first movements of the child's existence there is present neither of the two elements named by Preyer (see above). Certain it is, there is as yet no pleasure desired which serves as an end to be attained by movement. And, of course, having no clear idea of the end sought, the young creature can have no possible notion of the movements that are requisite to the attainment of certain desired ends.

The early movements of the child are no more voluntary actions than is the movement of the aspen leaf, of the brook splashing over the rocks as it tumbles down the mounta
of the stone that flies from the boy's sling shot, or of th
ball, as it describes its parabola of six or seven miles
waves and across the water when hurled from

clad at sea. The individual, the personality, must first have clear, definite idea of the movement and the purpose of it befor voluntary action can possibly be initiated. The difference betwee movements, such as we see in the waving grain, the ebbing tide the walking-beam of the monstrous ferry-boat, the ascendin balloon, the falling meteor, the crashing iceberg, and the impulsive reflex movements of the child, on the one hand; and on th other hand such movements as are exhibited by the wood-carve as he cuts a design,the etcher as he traces a plate, the pilot as h steers a vessel, the marine as he "sights" the cannon, the astronomer as he turns his telescope upon the dimly lit star, the youn belle as she learns to trip the light fantastic, the child of five or si learning to weave mats at the kindergarten, is that the latter ar *voluntary actions* or movements *plus* consciousness or attention Attention, then, or conscious effort (and these two are synonomous as you will readily see by reference to the chapter on attention), must be added to mere movement in order that movemen may become transformed into voluntary action. And yet yo must not conceive of attention and conscious effort as bein born long before will comes into existence, for attention or conscious effort is only a form or result of will effort. Concentrate attention upon a desired end is inconceivable without presupposing an active will force within the person.

Preyer's classification of the different movements that tak place is the one quite generally adopted, though, with Professo Tracy, we may say that the adoption of Preyer's classificatio does not of necessity commit one to his views with respect to th genesis of will.

First, we have the *impulsive* movements. By this group-nam it is intended to signify that large class of movements which tak place without the presence of any external stimulation, withou any sensory arousement to which the organism need make response. They are of course entirely outside of the domain of conscious attention and are therefore distinctly *will-less* movements [illegible] erely the result of an overflow of nervous energy.

[illegible] l, there are those movements that form so large a por tion of the early manifestations of activity on the part of the infant—especially in the early days of child life. Neither do these *reflex* movements involve the least degree of attention or conscious control. In fact they involve just the opposite. They, too, are characterized by an utter absence of the subject's power of attention or conscious effort.

We have, in the third place, what are called the instinctive movements. These instinctive movements constitute the majority of the activities in which animals engage, and are found to embrace a large number of the movements which human beings manifest. They are quite intimately associated with the emotional life and are so closely related to habit that we are apt to consider all our habitual movements instinctive. The instinctive movement is but slightly raised above the reflex movement, and is different from the latter in that it (the instinctive) is characterized by an element of consciousness not present in either the reflex or impulsive movements.

Finally, there is that large class of movements which are the pure results of deliberative choice—action in the truest and highest sense—voluntary action, which is indeed one of the essential characteristics of personality. No such thing as personality is conceivable without the power of self-direction—this action from motives and ideas toward aims and ideals. In this class of movements we have as essential features the desire of an end to be attained, concentrated attention upon this object or end, the imaging of this desired end before the mind, the picturing of the means to be employed in order to achieve it, and a forth-putting of energy in order that the desired end may actually be attained. These movements are really the *bona fide* voluntary actions, and we may call them deliberative or *ideational* movements. We shall now discuss the four classes of movements in the order named:

1. *The Impulsive Movements.*—Nearly all the movements that characterize the child's pre-natal life belong to this class. They constitute the larger number of acts manifested by the new-born child, as they do in the new-born animal. We know

simplest organisms possess the power of setting up movements independently of any external stimulus. The *source* of movement certainly lies within the individual organism as an inherent capacity. Now this is by no means the same as saying that such an automatic movement is causeless. These spontaneous or impulsive movements are brought about by internal changes, the setting free of accumulated energy. If you place the amœba under the microscope and examine it in the most cursory way, you will find that this simplest of organisms manifests incessant activity, is incessantly in motion. The amœba derives its very name from its perpetual modifications of movement, and movement, too, that is due to *internal* excitation; in other words, impulsive movements. In these spontaneous movements the internal changes set free a certain amount of accumulated or potential energy, which in turn depends upon the function of nourishment, and which is, of course, the fundamental and most primary of the organic processes. These impulsive movements, which are really produced by an overflow of nervous energy, are only possible because life itself is a process of taking in and using up certain constituents. But a further consequence of this is that the power of self-movement — movement utterly independent of external stimulation — denotes only temporary independence of such external conditions. Permanent spontaneity would be a consumption of one's own fat, a gnawing at one's own vitals, and under such conditions life would endure for only a brief space.

In the new-born child as in the new-born animal, the impulsive movements embrace all those spontaneous kickings, rollings, lip-suckings, cooings, jerkings of the head and arms, as well as the comical grimaces, all of which are such a paramount feature of the early weeks of infant life. The little fists are tightly clenched, the arms are continually performing wild gyrations, the hands are moved toward and from the face, toward and from each other, without being prompted by any definite purpose; in fact, nearly every muscle of the body is called into activity without the presence of any sort of external stimulus.

Most of the impulsive movements, indeed nearly all of them, disappear by the end of the child's second year, though some of them, like yawning or gaping, persist through life. Seemingly many of the impulsive movements are unexpected by the child itself. He cannot understand their purport and his surprise at some of them is quite marked and notable. The moving of the lips, even the first smile, belongs to this class of movements, as do those movements of the hands that accompany swallowing and also the rolling of the eyes in sucking.

While these impulsive movements in themselves are not volitional actions in the strict sense, they show that the organism is a little world in itself with the power of creating motions from within, and that it does not need to wait for external incentives to set it into activity. These impulsive movements are indeed the raw material which in the progressively unfolding will are so wrought upon by the child in its incessant activity that they are finally moulded and transformed, with the help of the other powers of mind, into the highest type of deliberative actions.

Reflex Movements.—Close upon the heels of the spontaneity which is manifested in the earliest stages of existence as a natural efflux of a superabundance of life, close upon these earliest self-movements in the path of development of the organism, *irritability* manifests itself. By irritability is meant the power of responding to an external stimulus. By reflex movements, then, we mean those that occur as a response on the part of the nervous system to external stimulation, without any participation of self-consciousness or the presence of any deliberation or choice. They never enter into consciousness during their performance, though sometimes we clearly remember them after they have been performed. These reflex movements are found in the adult as well as in the child; for example, the quick start on hearing the sudden report of a gun discharged near you, the quick withdrawal of the hand when one is picking berries and suddenly observes a snake coiled up in close proximity, or the startled jump made by the boy as he gets into bed and his feet come in contact with a cold, clammy banana skin surreptitiously placed there by *a mischievous* mate.

You see, then, that while reflex movements are not brought about immediately or directly by the internal state, but by a stimulus from the external world, they are nevertheless purely mechanical — they are most certainly not the result of conscious deliberation. While certain elementary feelings or sensations may be present, they are not made the subject of conscious elaboration into a desired end or object, toward the acquirement of which the activities ought to be directed. Höffding puts it succinctly when he says: "Reflex movement is, indeed, characteristic of the direct transition from excitation to movement. *Reflex effect is just as voluntary* as spontaneous movement."

Any simple reflex movement is one that is set up by a simple excitation (external). If, however, several excitations occur together, the effect depends upon whether the movements they each tend to bring about, harmonize or not. Thus a frog, minus a cerebrum, will croak if its back be gently stroked; but if at the same time his hind leg is powerfully stimulated, the frog will not croak. It might be well to interpolate the remark that the most effective inhibitions to reflex movements are supplied by the cerebral hemispheres. In the first years of life, while the cerebrum is as yet undeveloped, no reflex movements are inhibited.

Reflex movements are of the greatest importance and far-reaching significance in will development, for upon them the strictly voluntary movements are immediately dependent. In the processes of inhibition mentioned above, the will is greatly burdened in its course of development, for in the more refined form of this inhibition, the chief function is the voluntary and deliberate repression of the reflex movements. Among the earliest of the reflex movements to manifest themselves, are those concerned with the respiratory functions. The first cry the child makes as the air passes into its lungs, is certainly of this character, for
bra [illegible] dren make themselves heard in the first moments of
[illegible] ll as do normal children. In many new-born chil-
[illegible] y if much light be admitted to the room, sneezi
[illegible] e of crying, and is a pure reflex action, and as

it continues through life. We need only to allude to certain other of the respiratory reflexes—such as coughing, choking, hiccoughing, and the like, all of which are to be observed from the very first days of infant life.

It is claimed that starting from a sudden noise or jar is not present at the very first; but I have observed two very good instances which plainly show that it may be present. My own little girl, when but two hours old, was observed by me to start suddenly when I dropped the sliding window-screen so as to make a sudden noise. I made no less than three trials, each of which was successful in provoking the reflex movement—a sudden start.

The reflex movements of the limbs are quite numerous and manifest themselves rather early. On the seventh day Darwin tickled the sole of his child's foot with a piece of paper; the foot was jerked away and the toes curled up.

3. *The Instinctive Movements.*—In so far as a line can be drawn between the reflex movements and the instinctive movements, it must be by saying that the latter are more complex, more active and more conscious than the former. Instead of the momentary nervous discharge so plainly manifest in reflex, as well as the impulsive movements, there is a direction of the activities to a more or less distant end. Stimulus is required in order to set an instinct to work, but the kind of action is determined far more by the motor tendencies implanted and habits inculcated in the individual than by the nature of the stimulus. The stimulus serves only to open the valve that the motor tendencies may escape. The stimulus "presses the button," the reacting organism "does the rest."

You can also see that they differ from impulsive movements in that they do not take place in the absence of appropriate external stimuli. They also differ from impulsive movements in that they have an end or purpose, though, as Tracy remarks, this end may [illegible] known at the [illegible] the performance. They are also colored [illegible] itions. Thus, "a child in a [illegible] when his toes are tickled." The rise of right or left handedness belongs to this stage of instinctive movements. Professor Baldwin's experiments along this line are very interesting. He found:

1st. No trace of preference for either hand manifested, so long as no violent muscular exertions were made. In more than 2,000 experiments one hand was preferred as often as the other.

2d. From the sixth to the tenth month, the tendency to use both hands together was about *twice* as great as the tendency to use either hand alone. Out of 2,187 experiments, right hand was used alone 585 times; left hand, 568 times; both hands together, 1,034 times.

3d. Right-handedness developed under a pressure of muscular effort. Preference for the right hand manifested itself in reaching where violent effort was required, in the eighth month. Experiments show that in such violent effort, the right hand was preferred 74 times, the left 5 times, and *both* hands but *once*. Under the stimulus of bright colors, the right hand was employed 84 times and the left hand but twice.

The instinctive mouth movements are sucking, biting, chewing, and the like. According to Preyer, a child sucks, bites, smacks its lips, chews and licks just as instinctively as a chicken picks up corn and insects. The same holds true, in a great measure, of sitting, standing, creeping, walking and running.

"It is an important epoch in a child's life when he succeeds in standing alone. Whole sets of muscles, heretofore scarcely used, are now brought into activity, and his progress is, from this time on, more all-sided and symmetrical. Hitherto his locomotion has been only in the form of creeping (which is performed in a great variety of ways, some children paddling straight ahead on all-fours, like little quadrupeds, some hitching along in an indescribable manner on their haunches, and some going backwards, crab-fashion); but for the child who has learned to stand alone, the transition to walking is, in a very literal sense, "only a step." The first conscious steps are taken very timidly, and with an evident fear of falling. But frequently the first steps are taken unconsciously. Sometimes a child who has learned to walk, partially or wholly, reverts for a season to creeping, for no apparent reason. Children who have older brothers or sisters are likely to walk at an earlier age than others, on account of the example and assistance of these older ones. At first the feet are placed disproportionately wide apart, giving rise to a curious waddling motion; while sometimes a child *runs* instead of walking, and staggers, with the body inclined forward, and the hands stretched out as though he were afraid of falling, the feet, too, being lifted higher than is necessary. Many children seem more amiable after they have learned to walk, doubtless on account of their newly acquired ability, which not only occupies their attention, but enables them to go more readily to the objects of their desire." *

4th. Ideational Movements.—We can best study the genesis of ideational movements when we note how the will gradually brings the bodily movements under its control. This is indeed the first important accomplishment in the course of the will's training, and is so important that *motor-ideas must be considered as the basis of all conscious volition.* To all external appearances action is directed from within outward, but even this presupposes an *inner* activity—a determining of the ideas by the thought of an end to be attained. The thought of an end is the most important element; indeed, it is the distinguishing characteristic of all ideational movements. Passing over the impulsive, reflex and instinctive movements in turn, we find that ideational movements are different from each and all of these in that they [ideational] involve the previous portrayal or re-presentation to the mind of an end sought, an object to be acquired, or an aim to be realized. It is only to such movements as these that the term "voluntary actions" can be applied. All the other classes are only *movements*, in just the same sense that movements among physical phenomena are movements.

In the higher forms of will activity, then, we have the presence of motor-ideas that are determined by the thought of an end or desired object. Certain conditions are essential in order that we may have these motor-ideas. The first condition is that *movements must be made which are felt*. This shows that ideational movements exist only by virtue of the spontaneous, reflex and instinctive activities.

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* "*The Psychology of Childhood*" by Dr. Frederick Tracy, p. 56.

Impulsive and reflex movements constitute the material which serves as the basis of our motor-ideas.

In the most elementary and primitive manifestations of will, the distinction between sensation and motor impulses does not appear as yet. The reflexes as well as the instinctive movements are characterized by the fact that the external excitation—the stimulus—immediately evokes a movement; a sensation may indeed be felt, and also a feeling of pleasure or pain, together with a certain restlessness, if constraint be applied; but memory, and of course motor-memories, play no part. "*A motor impulse presupposes the memory of executed movement.*" This memory may consist in remembering the appearance of the movement, or in remembering the previous motor sensation itself. The latter is what we really mean by a "motor-idea." If the previous movement has had unfavorable, painful consequences, the memory image of this movement will, of course, be associated with pain, which will tend to prevent the repetition of the movement when the occasion again presents itself in consciousness. On the other hand, there will always be a tendency toward the repetition of movements that, when previously executed, evoked certain pleasurable sensations, and which pleasurable sensations have been remembered and re-presented in consciousness.

That it is this precedence of the motor idea which causes any movement to assume the true voluntary character, was made clear by Professor Münsterberg in his admirable little treatise, "Die Willenshandlung." Indeed, Münsterberg was the first to champion this view in any thorough-going and consistent way. One of the most terse of his sentences reads: "We *will* execute a certain motion, really signifies that we are conscious of the idea of the motion, or of the motor idea."

Professor Preyer divides ideational movements into three classes: (1) imitative movements; (2) expressive movements; (3) deliberate actions.

(1). *Imitative Movements.*—Under this category are subsumed all those lower voluntary activities in which the child depends upon an observed model or pattern, and which would never be attempted by the child unless first observed in some one else. This imitative propensity begins as early as the third or fourth month, in imitation of sounds, the pouting of the lips, etc. Preyer tells us of his child that "the first attempt at imitation occurred in the fifteenth week, the child making an attempt to purse his lips when one did it close in front of him, while in the seventeenth week the protruding of the tip of the tongue was perfectly imitated once when done before the child's face, and the child smiled at this strange movement, which seemed to please him." We quote again from Professor Tracy, who by the way, in his published thesis—"The Psychology of Childhood"—has given us the best epitome of the literature on the subject:

"There is no point on which I find so much uniformity as this, that imitation begins during the second half of the first year. This is true of almost all children without exception, so far as I know, and extends not only to movements proper, but also to vocal imitation, as we shall see. A boy of seven months tried hard to say simple monosyllables after his mother. Another is reported to have accomplished his first unmistakable imitations when seven months old, in movements of the head and lips, laughing, and the like. Crying was imitated in the ninth month, and in the tenth, imitation of all sorts was quite correctly executed, though even at the end of the first year *new* movements, and those requiring complex coördination, often failed. A child of eight and a half months, having seen his mother poke the fire, afterwards crept to the hearth, seized the poker, thrust it into the ash-pan, and poked it back and forth with great glee, chuckling to himself. Another child in his tenth month, imitated whistling, and later, the motions accompanying the familiar 'pat-a-cake,' etc. In his eleventh month he used to hold up the newspaper and mumble in imitation of reading. Another boy, in his eleventh month, used to cough and sniff like his grandfather, and amused himself by grunting, crowing, gobbling and barking in imitation of the domestic animals and birds. A little girl of this age used to reproduce with her doll some of her own experiences, such as giving it a bath, punishing it, kissing it, and singing it to sleep. One fine morning in May, I took the little boy, R., for a walk through a beautiful avenue, where the trees on each side met overhead in a mass of foliage. These trees were full of birds, busy with their nest-building, and full of song. The little fellow was fairly enchanted. He could not go on. Every few steps he would stop (at the same time pulling at my hand to make me stop, too), and looking up into the trees, with his head turned on one side, would give back the bird-song in a series of warbling, trilling notes of indescribable sweetness. I very much doubt whether any adult voice, however trained, or any musical instrument, however complicated, could produce those wonderful inflections. The same boy, a little later, used to imitate with his voice the boys whistling in the street, giving the right pitch. Another boy, at thirteen months, brushes his hair, tries to put on his shoes and stockings, and many other similar things. Indeed the whole life of the child of this age is full of imitation. Going out with the girl, F., I observed that she did almost everything I did; I brushed some dust from my coat and she immediately 'brushed' her dress in like manner. It is in fact difficult fully to realize how the child of this age is watching our every movement, and learning thereby. Not only parents and teachers, but every one who comes in contact with the child, even casually and occasionally, contributes his share, whether he will or not, in the child's education. The moral of this is too obvious to require repetition."

The child's tendency to imitate those about him is a very important factor in furthering the development of will. From a very early period it is right in line with the force of the child's personal desires, thus tending greatly to a shortening of the process of acquisition in the case of useful movements which he [illegible] therwise perform. Thus a child, thrown into company with other children who are just able to walk, learns to walk much more quickly than a child cut off from the example of others.

Children vary greatly in the strength of the impulse to perform imitative movements. Much depends upon bodily health, inherited vigor, hygienic conditions, nourishment and the like. An energetic child, one with a full head of steam, is much more likely to pick up the movements of others and imitate them, than a child that is poorly nourished, feeble and lethargic. Much depends upon the temperament—a child of an independent, self-assertive turn of mind will do little in the line of imitating others' movements, for such a child prefers his own mode of activity.

But it must be remembered that imitation is more than mere reproduction. The chief value of imitation lies in the fact that it necessitates a sort of unconscious selection and synthesis of former movements. Thus, the child could not learn to wave its hand in obedient response to a wave of the hand by the mother, if he had not already acquired a certain stock of experiences in waving the hand in other ways—in the impulsive and reflex movements. This higher form of *constructive* imitation presupposes, of necessity, a certain fund of remembered motor experiences.

2. *Expressive Movements.*—The most important group of the expressive movements is that which comprehends the movements involved in speech; but the expressive movements of the face and dermal appendages must also be included—blushing, crying, bristling of the hair, laughing. Likewise certain movements of the head and a large number of gestures fall under the same rubric —"expressive movements."

The first cry or the first smile is in all probability the result of an external stimulus, and the movement itself a reflex one. But a movement that is at first reflex may become the intentional expression of the mental states. Certain it is that crying, gesturing, and the like, later fall under the control of the will and become purposive expressions of the conscious life.

The first so-called smile has been observed in children less than two weeks old, but it can, in such cases, be regarded as only an impulsive movement—the outcropping of a superabundance of pleasurable feeling. Preyer found that a smile could be evoked very early by tickling the sole of the infant's foot. In the case of his own child he observed such a smile on the sixteenth day after birth, and "real smiles from the twenty-sixth day on; in the eighth week enjoyment of music was manifested by laughing and smiling, accompanied by lively movements of the limbs and a bright, gleaming expression of the eyes. The imitative laugh began about the ninth month after birth." Mrs. Talbot's account of the genesis and development of the smile is very interesting in this connection:

"The smile begins when the infant first begins to be conscious of outside things; attention gradually becomes closer and more fixed; the smile at this stage is a mere stare, vacant at first, but growing steadily more intelligent and wondering in its appearance. About the third week this begins to relax very slightly into the appearance of pleasure. At this point there comes more and more of a glow on the face—a beaming—then in a day or two a very slight relaxation of the muscles, increasing every day. This dawning smile is often very beautiful, but it is not yet a smile. It is *almost* a smile, and I am confident that no one will ever know the exact day when the baby fairly and *intelligently* for the first time *smiles*."

The kiss is an expressive action, not at all hereditary, but acquired and embodying an imitative element. "The child seldom understands its meaning or gives it spontaneously till in the second year."

Preyer tells us that there are no less than three sorts of pouting, and these differ from each other according to the specific cause. The first variety is merely a protrusion of the lips, which can be seen in the very earliest hours of life, with some children. It is hardly necessary to say that it is purely impulsive. The second kind embraces what is commonly known as the pursing of [illegible], pinching them as we do in later adult life during strained attention. The third is the pout of sullenness, which develops much later than the others, and cannot be said to be due to imitation, for it frequently occurs where no opportunity for imitation is afforded.

Shaking the head in dissent and nodding it in approval arise from different sources. The latter is acquired, but the first is the result of a defensive movement (due to certain hereditary tendencies), made frequently as early as the second week, when one attempts to put food or any object into the infant's mouth when it is not hungry. We are told of some instances of this side to side movement of the head, in children not more than one week old.

But we must pass to the remaining group of ideational movements.

3. *Deliberative Movements.*—In order to perform deliberative or voluntary movements in the strict sense of the term it is certainly necessary that one first have an extensive experience with movements of the involuntary sort. A voluntary movement is one which is pictured beforehand in the imagination. No voluntary act is possible without a motor-idea, and this motor-idea is supplied by either the memory or the reproductive imagination in the form of re-presented movement. Many movements that are at first performed involuntarily are afterwards performed deliberately, *i.e.*, from a desire to attain a certain end or object present in the imagination or the re-presentative consciousness. When desire, in the proper sense of the term, comes into being, a certain amount of attention is bestowed upon the object sought, and the motor-ideas are re-presented and kept in mind, we have what can correctly be designated deliberative or voluntary action in the true sense. In this truly voluntary action, then, these three things are necessarily presupposed — desire, attention and motor ideas. By means of several varieties of involuntary movement the child gains some experience with his powers, thereby learning the results of bringing these powers into activity, and voluntary movement is thus really the outgrowth of trial and e
ence. *Preyer* found no movement in the first three w

which he could regard with certainty as a strictly deliberat movement.

This brief survey of the various kinds of will acts shows ag the importance of the distinction between voluntary and n voluntary attention, made in a previous chapter. While n voluntary attention has the character of an instinct, volunta attention makes its appearance as a sort of impulse; being s sequently guided by an *idea* of what it desires to perceive, becomes capable of being developed "into clearly-conscio *choosing, will.*" The endeavor on the part of the volunta attention to retain and call forth certain memory-images a motor-ideas is characterized by a feeling of effort.

In this rich fund of spontaneous, reflex and instinctive mo ments, nature has really paved the way for our highest types deliberative volition—volition in the truest and best sense. B at the same time, nature in so doing gives us too much and t little. These strong, impulsive movements, which are p mordial, must be guided into a definite direction and modifi both in degree and kind before they can serve the purpose self-conscious personality. Thus, nearly every movement of t body is at first produced impulsively, involuntarily and at ra dom; but afterwards they are either retained and repeated, or hibited and suppressed. At first none of the reflex or impulsi movements are inhibited, but education represses them more a more. The little child whose higher brain centers, whose ce bral hemispheres, have as yet no active influence, lacks the c trolling apparatus which is the condition of all self-restrai The extent to which practice and accommodation may go, exhibited in the case of the Siamese twins, whose bodies h grown into one and who had brought their movements into s harmony that, as necessity arose, and without any preconcer signal, they could walk, run and jump just as though they h been one single individual.

This process of inhibition, by means of which the will obta such power over the body, goes on much more slowly in man th in animals. The child needs two years for the same course education that requires the kitten but a month to go through. This ability to inhibit movements is certainly one of the most certain criteria of the presence of will. To keep from moving is certainly more difficult than to move, especially in a being so restless as a child naturally is. To will is to bind or commit ourselves to something definite. This can be done either in the way of inhibiting certain tendencies to move, or in deciding upon a certain definite kind of movement.

The course of development that follows the will in its evolution is well set forth in the following words of Professor Höffding of the University of Copenhagen:

"Nature gives us from the first an impetus, for we find ourselves already active at the birth of consciousness. Consciousness only gradually acquires an influence over the activities (whether inward or outward), and this influence never becomes complete. The spontaneous impulse to movement, the reflex movements, and the half-conscious movements accompanied by an obscure feeling, preserve a certain independence, even after conscious thought has nominally taken the direction of affairs. Similarly with involuntary series of ideas and with emotions. The unconscious and the involuntary play a part, to an extent varying in individual cases, in all conscious volition, and sometimes break into open revolt. . . . These unconscious tendencies to activity are not noticed so long as they bend in the same direction as the conscious thoughts and feelings. Their force merges with that of the conscious motives, which latter receive the honor or shame of the whole action. We feel ourselves free and unchecked in our activity. It is only when these unconscious tendencies work against the end of conscious endeavor, that attention is called to the fact of a something in us, of which we are never, or at any rate, not at the moment, master. This sense of inner division, of a contradiction, is at the same time a feeling of constraint. Such a feeling of constraint often denotes a transition to a higher stage in the life of the will. It is the condition that makes it possible for us to pronounce judgment upon our *earlier volition*; for while our will works on with undivided energy, there is no room for an estimation or a judgment, but we go straight ahead. Here is seen the great importance of the interval already mentioned. It may conduce to a stoppage, even to a hesitation and a discord in the mind, *but it is necessary to higher development*. It may also lead to the absolute condemnation and rejection of the previous bent of the will."

The connection of one phase of mental development with all the others is well illustrated in the close dependence of *intellectual* growth upon the exercise of the will, especially in voluntary attention. We saw in Chapter XVIII, that, though chiefly related to the volitional side of mind, attention is the primary condition of all intellectual operations. All the higher forms of mental activity show plainly the necessity of the exercise of the will in the way of concentration. This makes intellectual growth the direct outcome of will-development: for it is voluntary concentration that makes possible the highest and most worthy activity of all the mental processes.

LESSON XXIV.

TIME RELATIONS OF MENTAL PHENOMENA.

No sketch of Psychology would be at all complete if the discussion of the *duration* of our various mental acts be omitted. The measurement of the time rate of the various mental processes was, historically, almost the very first of the attempts made by the experimental psychologist to put the science upon an exact basis. Certain it is that "Psychometry" has interested and occupied more students than any other field of investigation in modern Psychology. Psychometry is the general term used to designate that department of research, which has for its object the measurement of the duration of the mental processes.

From the earliest times the question of the rapidity of thought has been discussed. We have always been conscious of thinking, sometimes faster and sometimes more slowly. This is a matter of universal consciousness. In times of excitement and mental activity, our ideas come quicker than a flash. We know that the rapidity of thought is prodigious in dreams—a whole "dream-plot" unfolding itself in a few seconds, which, in ordinary wakeful consciousness, would take hours to consummate. In a former chapter we discussed the influence of drugs upon the flow of our ideas, and found a good illustration in the account of Thomas De Quincey, who, when he increased the usual dose of opium, believed "that in one night he had lived a thousand years, or indeed a length of time that exceeded all human experience." We know, on the other hand, that thought in the half-witted, stupid person is sluggish.

But until a few years ago the various speculations with reference to the rapidity of thought, were nothing more than speculations—mere guesses. The subjective consciousness can veal to us which sensations travel the faster, for example, those of sight or hearing. The introspective psychologist can never give us any authoritative verdict on the time rate of mental phenomena. Whether it takes longer to choose between two colors than between two flowers can never be definitely settled by the student who adheres uncompromisingly to the old school. Experimental Psychology shows its hand perhaps better in the field of Psychometry than in almost any other department of the study of the mind and its forms of functioning. There is no fixed standard of measure in the inner life itself. The speeding thought must and can be measured just as truly by means of fixed, objective standards as can any of the phenomena in physical science. You can measure the time-rate of thought just as truly as you can measure the time-rate of sound or light. You can time the rate of a thought just as you can time the speed of a race-horse or of the college athlete in his "one-hundred-yard dash."

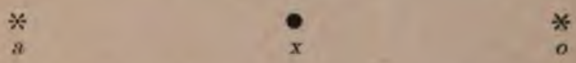
Instead then, of the vague subjective estimates with reference to the duration of the various mental processes, we can have *exact measurements*, made after fixed and unalterable objective standards. This is what the investigator in Experimental Psychology actually does. He proposes to give us, instead of the *crude estimates* of the internal sense, certain precise and absolute measurements of the exact duration of the individual states of consciousness. The time measurement of the mental processes is one of the chief ways of getting at the mental laws.

The attempts in this direction are indeed recent. The first ostensible time measurement of mental acts was begun by Donders in 1861. At the time he began there were, as there are now, some strong prejudices to overcome. There were also immense difficulties presented in the line of inexact and imperfect apparatus. So good a scientist as Müller wrote just before Donders began his work: "We shall probably never attain the means of ascertaining the speed of the nervous activities, because we lack the comparative distances from which the speed of a movement, in this respect analogous to light, could be computed."

B[illegible] now know that sensory processes travel along the nerves on an average of about one hundred and ten feet per second and often less than twenty-six feet. Not many years ago people employed such phrases as "as quick as thought" as the extreme standard of "rapid transit." It was even "quicker than lightning." But it is now a demonstrated fact that while you are performing one of the simplest mental acts, *e. g.*, deciding which is the longer word, "cat" or "Nebuchadnezzar," electricity or light would flash clear across the continent.

It is interesting at least as a matter of history, to notice that the first suggestion that lay at the basis of modern Psychometry came from the seemingly remote science of astronomy. It is related of Maskelyne, the astronomer of the Greenwich Observatory, that in 1795 he observed that his assistant, Kinnebrook, always noted the passing of stars across the meridian from .5 to .8 seconds too late, and thinking such negligence inexcusable, discharged him from his employ. Later, in 1820, in comparing his astronomical calculations with those of others, Bessel discovered what is known as the "personal equation."

Suppose the meridian is at the point *x* and the star is first at *a*, and a second after is at *o*.



The exact instant the transit occurs, *i. e.*, the precise moment at which the star passes the point x, is recorded, and it is found that the several astronomers always differ in their records as to the time of transit. They use the same standards or units of measure, the same kind of apparatus, the very same instruments, and get different results. This difference, then, is of subjective origin. One observer can see and record quicker than can his fellow observer. By "personal equation," then, is meant "such systematic errors in observation as originate in the observer himself, in distinction from those errors due to instrumental and atmospheric conditions."

Differences due to personal equation vary from .3 sec. to mo than one second, and vary according to the hour of the day, the circulation of the blood, fatigue and other causes.[*]

Next to astronomy, Psychology owes a debt to physiological experiment for opening the way for researches upon the time-rate of mental phenomena. In 1850 Helmholtz measured in a precise manner the time of the transmission of nerve action through a given nerve length, calculating the velocity of nerve transmission.

These deliverances of astronomy and physiology are, of course, but introductory to the problem before us: *the measurement of the duration or time rate of the mental processes.* Yet they do furnish certain elements that lie at the basis of our calculation. Within recent years there has been great improvement in specialization of methods and modification of measuring apparatus, so that we now have a body of facts and generalizations that are indeed quite valuable to every student of mind and its activities.

The general problem in all the attempts at such measurement as here indicated, is practically the same. This problem is to determine by precise measurement the exact length of the interval which elapses between the time a certain end-organ of sense is stimulated, and some form of resulting motion, which motion is really made to signify that the sensation has been perceived. For example, you are told that a bell is about to strike, and as soon as you have heard the sound, you are to press the electric key before you. The stimulus may consist of a sound (*e. g.*, a bell, musical note, falling ball, or click of an electric key), a touch, a stimulus of pressure, heat or cold, or it may be a visual stimulus, such as the appearance of one or more colors or figures, letters or words. The resulting motion is usually the pressing of the finger upon an electric key, or speaking into a "speech key," or merely parting the lips. The quickest movement that can be used in such experiments, to designate that the sensation has been received, is the most advantageous because there is less room for variation. By a large number of experiments, Dessoir found this most rapid movement to be that made by bringing the thumb and index finger into contact with each other. Ewald declares the quickest form of reaction is simply to *lift* the finger from the key. Dessoir has devised a finger contact key that is very simple but effective. Two metallic thimbles are placed in circuit. One of these thimbles is worn on the thumb, and the other on the index finger, and electrical contact is made by bringing finger and thumb together. A very good piece of apparatus is a new and modified form of the speech key, in which the electrical circuit is made and broken by the movement of the lips. Thus you start the chronoscope when you present a column of figures to the eye for the subject to add, which he does as rapidly as possible; he stops the chronoscope by breaking the electric circuit in parting his lips when he announces the result of his mental operations. It might be of interest to know that we can measure as small a time interval as $\frac{1}{100000}$ part of a second with reasonable accuracy.

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[*] For the best discussion of "The Personal Equation" see the interesting and exhaustive article of Prof. Sanford in "American Journal of Psychology," Vol. II.

All endeavors to measure the time rate of the mental processes begin with the problem of simple reaction time. By simple reaction time is meant the time that elapses between a single stimulus, the quality of which was known beforehand, and a predesignated movement. Let us together perform an experiment to illustrate simple reaction time, and I think we will have a clearer notion of what is meant. The experiment, which we plot beforehand, consists simply in this: I agree to press the electric key on which my finger is resting as soon as I feel you touch my forehead with a pencil. Now the time that elapses between your touching my forehead and my pressing the electric button would be rightly called simple reaction time.

You say at once that that is such a simple experiment. Well, let me remind you that the simplest of reaction times is a very complex affair. There are no less than five distinct elements in this shortest of mental reactions: (1) The impression of the sense-organ, as when you touch my forehead with the pencil; (2) the transmission of the impulse along the appropriate nerve fibers to the brain; (3) the transformation of this sensation impulse into a motor brain process; (4) the conduction of this motor impulse outward to the organ that is to be moved. In our simple experiment it is the transmission of the motor impulse to the finger that is to press the electric button. (5) The contraction of the muscle or the setting free of the muscular energy, as in the actual movement of the reacting finger.

The factor of most vital interest to the psychologist is the one numbered (3), the real central or brain factor in this whole process. But, taking up each of these factors in turn, we have to consider:

(1) The *inertia of the sense organs* is determined by measuring how rapidly a number of sense stimuli may follow one another without being fused together. Thus, how rapidly may touches be made upon the skin at the extremity of the index finger, that my mind may perceive them as single, separate and disparate sense impressions? Or how fast can electric sparks flash before my eye and I still be able to perceive each separate flash? You can readily see that, since the nervous system is constructed as it is, at least some small fragment of time must elapse before the nerve elements are aroused. Also that when they are once excited, the effects of the arousement would continue for some little time after the stimulation itself has ceased.

Experiments with reference to the inertia of the sense organs have been most satisfactory in the realms of touch, hearing and sight. With reference to touch, it must be said that the different parts of the skin differ so with respect to sensitiveness and power of recovering from former stimulations, that we have no general results for all parts of the body where sensations of contact may be experienced. You remember that the skin over the lips is so sensitive that the two divider's points may be very close together and still be felt as two, while if applied to the small of the back, they must be as far apart as two and one-half or three inches in order to be perceived as two. So with reference to the rapidity with which touch stimulations may be applied and yet felt as separate discrete. The most satisfactory experiments, I think, were of Sergi, who found that as many as 1,000 touch stimulations could be applied to the finger and yet be felt as discrete. With reference to hearing, it has been found by experiment that the noise of the electric spark, heard with one ear only, has been distinguished at intervals of only .002 of a second. The number of separate sensations of sound possible under the most favorable conditions is, therefore, about 500 in a second. For vision the stimulations must be as far apart as $\frac{1}{25}$ of a second. You see then that the time sense of the finger is most sensitive, since it can perceive $\frac{1}{1000}$ of a second; that of the ear is next ($\frac{1}{500}$ of a second), and the eye is comparatively slow, being able to perceive accurately not less than $\frac{1}{25}$ of a second. As yet no satisfactory method has been devised for measuring the time sense in the smell and taste domain. The inertia of these two senses cannot be computed with any reasonable degree of accuracy.

The rate at which a nervous impulse may be transmitted has been determined by experiment upon both animals and man. It varies with different individuals, under different conditions and in different nerves. As already intimated, the sensory processes travel along the nerves on an average of only 110 feet per second, and often less than 26 feet. This is exceedingly and surprisingly slow when we stop to think that light travels faster than 180,000 miles in a second. While you or I would be performing the simplest mental act, electricity would have shot across the continent.

There are many conditions which certainly affect the reaction times in all individuals to a greater or less extent. These conditions may be grouped under two general heads: (*a*) subjective; (*b*) objective. By the subjective conditions we mean, of course, such as affect the mental attitude of the person reacting. By objective conditions we mean those that affect the external features of the experiment. We shall first discuss the latter group.

In the first place, much depends upon the *nature of the impression.* The reaction time will vary considerably according to the organ stimulated. The average for the sense of sight is .185 sec., for the sense of touch it is .147 sec., while for hearing it averages about .136 sec. It is commonly supposed that sight is the quickest of the senses; but this is not the case, as reference to the above figures plainly shows. Hearing is by long odds, the quickest of the senses. The senses of taste and smell are both much slower than the others, and the time is different for the different kinds of taste and smell stimuli. For smell, oil of roses takes .275 sec., musk .315 sec., and ether but .255 sec. It requires a longer time to perceive bitter than it does to perceive sweet tastes; a longer time to perceive acid tastes than it does to perceive those that are saline in quality.

In the second place, *the intensity of the stimulus* plays an important part. Within moderate limits the time decreases as the stimulus increases. Wundt and Cattell, in the study of reaction time, found the effect of increasing the stimuli for sensations of sound, to be something as follows:

The noise made by the hammer falling from the height of

	Reaction time.
1 millimeter	0.217 sec.
4 millimeters	0.146 sec.
8 millimeters	0.132 sec.
16 millimeters	0.135 sec.
2 centimeters	0.161 sec.
5 centimeters	0.176 sec.
25 centimeters	0.159 sec.
55 centimeters	0.094 sec.

Berger and Cattell varied a light stimulus from 7 to 23, to 123, to 315, to 1,000 units of intensity, and found that the time for perceiving each was as follows:

Intensity.	Reaction time.
7	0.210 sec.
23	0.184 sec.
123	0.174 sec.
315	0.170 sec.
1,000	0.168 sec.

The third objective condition that affects the reaction time is the *manner of the reaction.* Simple movements and those made familiar by practice, shorten the reaction time as compared with the more complicated and unusual movements. Thus, to announce the reaction by speech requires a longer time than to announce it by pressing the index finger against the electric key.

With reference to the subjective factors we would say, in the first place, that the *element of expectancy* shortens reaction time. The more definite this foreknowledge is, the quicker is the reaction. Thus, if a preceding signal, at an interval neither too great nor too small, informs us that we are about to be called upon to react, the reaction time is necessarily diminished. If we experiment once with such a preceding signal, and then at another time do not use the signal at all, we find the reaction time shorter in the second case. Thus, with the warning signal Wundt reacted in 0.175 sec., while without any such signal it took him 0.266 sec.; and Götz Martius found that with the signal he reacted in 0.127 sec., while without it 0.178 sec. were required to complete the reaction. The time-interval required for perceiving the sound of a ball falling 25 centimeters, without a preliminary signal, was 0.253 sec., but with such a signal, was reduced to 0.076 sec. When the fall was 5 centimeters the reaction time was reduced from 0.266 sec. to 0.175 sec. In order to secure such favorable results, the signal must be of a nature not to distract the attention of the person reacting, and must precede the stimulus by a rather constant time-interval, and this interval between the preliminary signal and the actual stimulus should not be so long as to overstrain the attention. The most favorable interval between signal and stimulus is from one to two seconds.

Again, the *effect of distraction* must be noted. The distraction may consist in having a disturbing noise in the room where the person is reacting; or better, have this person's mind engaged in performing some other mental task at the same time, such as beginning with the number 9 and adding 2 continuously. Wundt's reaction time was thereby lengthened from 0.189 sec. to 0.313 sec., when the disturbing element was an unusual sound in the room. Cattell's reaction time was lengthened as much as 0.030 sec. when mentally occupied with simple addition, such as indicated above, during the reactions. Some persons are exceedingly sensitive to disturbances, while others are not at all so.

A word must also be said with reference to the *effect of practice and the influence of fatigue.* Practice and concentrated attention increase the speed of our mental processes, while fatigue, of course, diminishes them. The accuracy is less when the person is fatigued, while greater exactness is induced by practice and attention. Practice has been found to diminish the reaction time by as much as one-third. Fatigue, or anything else that makes excessive demands upon one's nervous energy, such as the heat of a sultry summer day, or the enervation that follows a sleepless night always lengthens it. In cases of idiocy, imbecility and epilepsy, the length of this time interval for reactions is greatly increased. The simple reaction time of an old mendicant in the alms-house was at first as much as 0.9952 sec., which by practice was lowered to 0.1866 sec., but could not be gotten below that figure. Dr. W. Bevan Lewis furnishes us the following table showing the reaction time of certain of the epileptic insane:

REACTION TIME IN EPILEPTIC INSANITY.

		Sound Stimulus.	Sight Stimulus.
J. J.	Depression with dementia, sluggish...	0.200 sec.	0.232 sec.
B. L.	Dementia, suspicious, violent...........	0.219 "	0.295 "
J. V.	Maniacal, gross delusion....................	0.211 "	0.251 "
J. I.	Dementia with excitement.................	0.220 "	0.258 "
M. C.	Hemiplegia, querulous........................	0.223 "	0.251 "
W. H.	Dementia, apathy..............................	0.223 "	0.262 "
R. H.	Advanced dementia, torpor...............	0.240 "	0.265 "
S. F.	Bright aspect, lively, excitable, but childish and unstable..................	0.281 "	0.300 "
R. T. R.	Bright and lively aspect, but of sluggish intelligence.....................	0.297 "	0.294 "

It might also be intimated that the appearance of sprightliness and quickness does not of necessity signify a speedy and accurate performance of the psycho-physical processes that are involved in the most simple reactions. Of two young men experi-ted upon by Exner, one was found to be of a very lively temperament, while the other was regarded rather sluggish. Experiment revealed that the simple reaction time in the former of these two persons was as much as 0.3311 sec., while in the latter it was but 0.1337 sec. This question of individual difference was sufficiently discussed in connection with the subject of "personal equation" at the beginning of this chapter. The effects of drugs and narcotics upon the quickness of the mental processes received sufficient treatment in Chapter IV. where Münsterberg's recent and extensive experiments were referred to.

We must now turn the attention to the discussion of the more complicated reactions. If, instead of reacting in a certain prescribed way, previously agreed upon between reactor and experimenter, we have different sorts of stimuli, each to be reacted to in a definite way, thus introducing the element of adaptation or selection, we have a complex or discriminative reaction. Let me illustrate the difference between the two kinds of reaction. Suppose you are facing the black-board, on which any letter or character may be written, but is covered by a screen or by my hand. As quick as I remove my hand and you see the letter, you touch the electric key or react in any other way to signify that you see a letter. In the second place, I tell you that my hand conceals either the letter A or the letter B; if the letter A is displayed on removing my hand, you are to react by pressing the electric key with the index finger of the *left* hand; if the letter B is shown, you are to press the electric key with the thumb of your *right* hand. Or, if a blue color is displayed, you are to press the key with the *index finger* of your right hand, and if a red color, you are to react with the *middle finger* of the same hand. You see, then, in these two latter cases we have, as distinguished from the first, simple reaction *plus* selection, which selection depends upon a definite recognition of the stimulus (*e. g.*, whether A or B; or whether red or blue), and a choice between the movements (*e.g.*, a movement of the index or middle finger). This added time made necessary by the element of selection is called "Discrimination Time," or "Discernment Time."

Donders was the first to experiment in this line, and had a *simple* reaction time of 0.201 sec. He then devised experiments in which he was to reach with the right hand to a red light and with the left hand to a white light. This latter complicated form of reaction took 0.355 sec., or an increase of 0.104 sec. This 0.104 sec. really represents the discernment time; it is really the measure of the time involved in the purely mental processes employed in the selection of means and manner of reaction to certain specific stimulations.

It remains for us to name the conditions that affect these more complex reactions.

(1) The number of distinctions and choices possible.

(2) The foreknowledge of the subject, or the element of expectancy on the part of the reacting person.

(3) The complexity of the impressions. Thus, pictures are recognized more quickly than letters, letters more quickly than words, English words more quickly than words of a foreign language. As already intimated, the quality of the sensation makes a great difference with respect to the ease of adaptation and perception. Salt is recognized more quickly than acid; acid more quickly than sugar; sugar more quickly than bitter; the rate for these various tastes in adaptive reactions being 0.384 sec., 0.394 sec., 0.409 sec. and 0.456 sec. respectively.

(4) Where overlapping of the mental processes is possible, there is a consequent shortening of the reaction time. The mental processes do naturally overlap one another. Compare, for example, the time *per word* when reading one hundred words or letters with the time occupied in reading a single word or letter. Thus the time per word in reading 100 words is 0.255 sec. and the time required for a single word is 0.430 sec. The time *per letter* when 100 letters are read is 0.224 sec., while the time required for a single isolated letter is 0.424 sec. Professor Cattell made a series of interesting experiments in this line by reading letters through a slit in a screen behind which letters moved across the field of vision. When the size of the slit was increased so that [illegible]mber of letters visible at one time increased, the time for a single letter was greatly diminished.

We have yet to speak of that form of reaction generally grouped under the rubric—"Association Time." A great many reactions must be viewed as responses to questions put by the experimenter to the person reacting. The reactions that are comprehended in this group certainly vary greatly in character. We here give some of them, that you may note the comparative quickness of the various reactions that come under this class. When the questions admit of more than a single answer, of course the reaction time is greatly lengthened.

ASSOCIATION TIME FOR VARIOUS JUDGMENTS.

	SECONDS.
To name the season when a month is given	0.248
To name the country in which a given city is situated [Paris]	0.278
To tell the language in which an author wrote [Goethe]	0.262
To name a German wine	0.485
To answer the question, "Who wrote Hamlet?"	0.958
To tell which is the healthier, swimming or dancing	1.354
To answer which is the more difficult, physics or chemistry?	1.500

We close our necessarily brief discussion of this interesting subject of reaction time by submitting the following table, which gives in the terms of a second the average length of time required for some of our commonest mental judgments:

	SECONDS.
To recognize the direction of a ray of light	0.011
To recognize the color, when one of two, as red and blue, and expected to be seen	0.012
To recognize the direction of ordinary sounds	0.015
To localize mentally, when blindfolded, any place on our body, touched by another person	0.021
Mentally to judge a distance when seen	0.022
To recognize the direction of loud sounds	0.062
To recognize capital letters	0.180
To recognize short English words	0.214
To recognize pictures of objects	0.163
To add single figures	0.170
Given a month, to name its season	0.354
To answer the question, "Who is greater, Virgil or Ovid?"	0.750
To answer such questions as "Who wrote Hamlet?"	0.958
To name a French writer	1.258

LESSON XXV.

METHODS OF TESTING AND MEASURING THE MENTAL FA
ULTIES, ESPECIALLY MEMORY AND ATTENTION IN SCHOOL CHILDREN.

ONE of the most hopeful developments of modern Psycholo
is the attempt to attain exact measurements of the mental p
cesses. This introduction of a more and more exact mode
regarding the mental phenomena is bound to have importa
practical effects upon the theory and practice of education. F
no less than three reasons should the teacher undertake a sys
matic measurement of the faculties of his pupils.

First, a collection of such comparative measurements is great
needed in order that we may have a statistical basis for buildi
up a more exact Psychology of childhood. Thus, for exampl
If we wish to determine the order in which the various faculti
unfold and develop, it is almost absolutely necessary that we
able to determine the date at which each particular faculty begi
to acquire strength and manifest itself as a factor in the chil
mental life.

Second, this exact measurement of mental faculty is of excee
ingly great importance in carrying out the work of teaching so
to attain the best results. The success of any school or a
class depends to a great extent upon the arrangement of t
pupils of that school or class according to their special capaciti
and respective powers. Every classification of pupils pre-suppos
that the teacher has made an estimate of the child's abiliti
The common method generally pursued is an oral examinati
or some written paper, which is, however, a very meager criteri
by which to judge the child's real progress and mental develo
ment. These ordinary tests of the child's mental capacity a
exceedingly crude and unreliable. If such methods were e

ployed in the study of the various particular sciences, the conclusions attained would be utterly valueless. It is, therefore, of the utmost importance, in order that the teacher may classify the pupils according to their real ability, that we have a more exact method of measurement of faculty.

Third, by means of these exact mental tests we can find out just what is the defect that prevents the otherwise normal child from advancing in knowledge as he should. Whenever such a defect exists it ought to be known and provided for, yet it is certainly evident that many of these defects are deeply hidden and cannot be discovered unless we have some method of testing the children in various ways. Very frequently a child has been considered stupid when the real difficulty was obtuse hearing. More than once does a pupil find trouble in singing, an exercise which is becoming so prevalent in our public schools, when in fact he cannot tell two notes apart within an interval of a couple of tones. How exasperated some teachers become at the distorted drawings produced by some of their pupils, when the real cause of this incapacity is an inherent defect in the child's power to estimate distances by the eye, which could only be removed by some special practice or instruction with reference to it.

The prime object of measurement and testing children periodically—for example, once a year—is to determine whether their minds are in proper condition for the school work that has been assigned to them, and also to discover whether there are any underlying defects of sensation or intelligence that must be guarded against in the course of instruction, and finally, to determine whether the child has developed at the proper rate.

Another consideration that might be mentioned is that Psychology can never attain the certainty and exactness of the physical sciences unless it be founded upon experiment and measurement. A step in this direction, especially in the Psychology of childhood, can easily be made by applying a series of mental tests and measurements to a large number of individuals. These results are becoming more and more valuable, not only to the educator, but also to the student of Psychology, in that such results throw much light upon the mental processes, their interdependence and their variation under different circumstances. The more uniform these tests are, the more valuable they would be for purposes of comparing different school methods, different climatic influences, the effect of the time of day, etc.

It is our purpose in this chapter to outline some simple experimental tests, such as every teacher may employ to advantage (with little or no apparatus), tests which will enable him to discover the exact nature of the child's mind at any age, with a view to properly guiding it on its onward course. The first test that we propose is a test of the condition of the auditory or ear memory. In this connection it would not be out of place to refer to that long series of experiments performed by Professor Ebbinghaus, of Berlin.

Professor Ebbinghaus subjected himself daily for two years to a series of tests, in order to examine the powers of retention and reproduction. After reading through a list of meaningless syllables once he could remember (that is, recite without a fault) but seven. Sixteen readings were necessary to learn twelve syllables, forty-four readings to remember twenty-four, while to retain only two more, twenty-six, required fifty-five readings. The second day of restudying so as to remember a list of sixteen syllables saved a number of seconds very nearly proportionate to the number of readings on the first day. With an unlimited amount of study the experimenter could not retain these sixteen correctly twenty-four hours. At first it is much easier to forget such a senseless list than later on, the loss being measured by the number of seconds required for a second relearning; for example, if the first learning took one thousand seconds, the relearning taking five hundred seconds, the loss between the two learnings would be one-half. During the first half-hour, half of the forgetting seems to occur. To quote directly from his published results:

"The initial rapidity, as well as the final slowness, as these were ascertained under certain experimental conditions, and for a particular individual . . . may well surprise us. An hour after the work of learning had ceased, forgetting was so far advanced that more than half of the original work had to be applied again before the series of syllables could once more be reproduced. Eight hours later two-thirds of the original labor had to be applied. Gradually, however, the process of oblivion grew slower, so that even for considerable stretches of time the losses were but barely ascertainable. After twenty-four hours a third, after six days a fourth, and after a whole month a good fifth of the original labor remained in the shape of its after effects, and made the relearning by so much the more speedy."

The question whether an idea can arouse another with which it was never in immediate contact—that is, without passing through the connecting links of ideas previously used—is among the many important queries raised by these researches. From the deductions which he made, Dr. Ebbinghaus was led to emphasize the statements that there are changes in the concentration of attention, and that theories and opinions unconsciously influence the mind in its power of reproducing images.

"Learning once a series of even sixteen 'nonsense-syllables' saves time on attempting to relearn this series, in whatever manner its members, when relearned, are related to each other." The strength of association, when estimated by this saving of time and relearning, is shown in the following table:

Saving on time on relearning is, between contiguous members..	.33	sec.
Saving on time on relearning is, skipping one syllable...............	10.8	"
Saving on time on relearning is, skipping two syllables.............	7.0	"
Saving on time on relearning is, skipping three syllables...........	5.8	"
Saving on time on relearning is, skipping four syllables	3.3	"

During his experiments in learning and relearning these "nonsense syllables" Ebbinghaus found indications of a remarkable rhythm in attention. "There is," he thinks, "a periodic oscillation of the mental susceptibility to intense concentration, in which 'the increasing fatigue seems to vary about a gradually shifting middle position.'" Thus in eighty-four experiments with six sixteen-syllable series, the mean time for learning the first series was 191 seconds; for the second, 224 seconds; for the thir [illegible] conds;

for the fourth, 218 seconds; for the fifth, 210 seconds; for the sixth, 213 seconds.

These experiments of Prof. Ebbinghaus have been verified by the more recent and extensive investigations of Prof. G. E. Müller and Dr. F. Schumann, of the University of Göttingen.*

The test that we have in mind is nothing so complicated as set forth in the experiments of these scientists. It consists simply in the reading of a number of meaningless syllables and series of consonants or numbers, and asking the child to repeat as many of them as he can remember. You will find here a series of tests that I employed, with the assistance of thirty or more teachers in the State of Illinois, in testing the auditory memory of school children.

SCHOOL TESTS FOR THE AUDITORY MEMORY.

(1)	4	9	6	3	7	5	1	8
(2)	7	1	5	9	4	7	2	6
(3)	5	7	2	6	9	4	8	3
(4)	2	5	8	6	4	9	7	3
(5)	6	8	4	7	1	9	3	5
(6)	9	4	7	1	5	3	6	2
(7)	3	5	1	6	7	9	4	8
(8)	8	2	9	1	5	3	4	7
(9)	7	2	5	9	6	8	3	1
(10)	5	8	7	4	9	2	6	8

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* "*Experimentelle Beiträge zur Untersuchung des Gedächtnisses*" *Leipzig, 1893.* This valuable work reached me too late to permit of a resumé here, which I greatly regret.—W. O. K.

The first set of these tests is made up of the numerical digits. The teacher reads a single series, for example, these: 4, 9, 6, 3, 7, 5, 1, 8. About ten seconds are employed in enunciating these numbers; immediately after they are read the child is asked to repeat as many of them as he can remember and in as nearly the same order as possible. The second series of tests here appended is made up of letters, consonants only being employed, and the test was performed in the same manner.

SCHOOL TESTS FOR THE AUDITORY MEMORY.

(1)	b	k	l	z	s	d	r	n
(2)	t	r	z	g	h	t	c	m
(3)	s	g	r	t	n	k	l	d
(4)	t	g	d	k	x	m	z	r
(5)	t	d	r	l	b	k	q	n
(6)	l	w	t	m	p	x	k	z
(7)	f	g	s	l	z	d	m	b
(8)	q	t	r	z	l	m	p	c
(9)	v	d	s	z	t	n	h	g
(10)	f	k	r	t	l	m	g	j

Perhaps one child will remember five digits or letters, in that case his auditory memory is expressed as a fraction of the task set before him. If he remember six out of the eight members of the series, his grade for auditory memory would be six-eighths or 75 per cent. Some one else will have remembered more or fewer, and his grade would of course be greater or le

These tests may be modified for any gr

necessary. In the highest grade probably as many as ten or twelve digits or letters can be employed in each series; in the middle school grades possibly no more than eight members should be embraced in a series. In the still lower grades it would be well not to employ more than six numbers in each series, and in the lowest grades even a short series should be read over three or four times, so that the child's powers may not be too heavily taxed. As a result of experiments such as herein indicated upon no less than 8,000 Illinois school children, I have reached the following conclusions:

First.—The limit of the memory span for the pupils in the public schools of Illinois, in the grammar and high school grades is seven.

Second.—This memory span indicates the power and concentration on the part of the pupil.

Third.—The girls have better ear memories than the boys.

Fourth.—The memory power of the ear increases with age rather than with the growth of intelligence, showing that actual experience is much better as a factor of development in this line than books.

Fifth.—With practice, the ability of the pupils to remember groups of digits or letters greatly increases.

Sixth.—The experiments show that some of the pupils in our Illinois schools suffer from fatigue. This indicates that the work in certain schools is either very poorly arranged, or else excessive.

Seventh.—These memory images pass through three stages in leaving the mind. The first sign of a disturbed memory is a confusion of the order in which the letters or figures are given; that is, the pupil does not remember the series in the precise order in which they were pronounced. Second, a loss of certain of the numbers entirely, and the substitution of other figures or letters for them; and third, a complete loss of certain of the letters or figures.

Eighth.—Ideas, or memory images at the ends of the series are [illegible] embered than those which occur at the middle; for ex- [illegible] he first of these numbered tests indicated above, the figures 4 and 9 at the beginning and 1 and 8 at the end of the series would be better remembered than the figure 3 or 7 at the middle of the series. If we find that the pupil cannot remember so well at noon as he could in the morning, and if he remembers still worse in the afternoon than he did at noon, we may conclude that he is either poorly nourished, or that the school work is fatiguing, and therefore excessive.

The next test should be made upon the visual, or eye memory. For this purpose a line such as the one shown above may be used. I have several of these standard lines printed upon small bits of cardboard and distribute them. I then collect these cards and ask each child to select *from memory* a line that is the same length, out of a group of five lines of various lengths, which I then place before him. If he have a good eye memory, he will have little difficulty in selecting the line of proper length.

A similar test might be proposed in which various syllables might be placed upon a card in some convenient form. This card should be held up before the child for a few seconds, and he then asked to repeat as many of the syllables as he can remember.

A third test might be advised in which visual, auditory and motor memory are combined. I hold up the card as before and he is to read the syllables or letters aloud. In this way the child not only sees and hears them, but moves the muscles of the larynx and tongue, which movement furnishes him with an additional memory clue.

Another test that might be employed in any schoolroom may be called a test upon powers of visual comparison.

Give to each child a clean card with nothing but a single horizontal line drawn thereon, like this:

Ask him to bisect it exactly in the middle or as nearly so as possible, judging the middle point with the aid of the eye alone, *no rule or measure* being employed. As a [illegible] act, no pupil will divide the line exactly at the middle point. The amount of error can then be measured by the use of a millimeter scale and calculated in per cent. with facility and accuracy. Now this exercise not only tests the visual judgment or comparison, but it also *cultivates* accurate perception. The child observes more and more closely with each successive exercise and finally reaches absolute perfection in his judgments, and close attention is also induced.

Draw a line—*e. g.*, six inches long, on the black-board. Ask all to observe it closely; erase the line; then ask your class to reproduce it—each draw a line as nearly as possible the same length as your original line. In the first exercise you will have lines of as many different lengths as you have pupils. Measure the error in each line, and calculate the grade of each pupil for visual memory in per cents. Or to make it easier and more simple, draw the standard line as suggested above; then erase, then draw five lines of different lengths, one which is the same as the first or standard line, the other four various lengths, but each differing only a little from the standard line, being either a trifle longer or shorter. Number these lines, and then ask your pupils to select the one of the four which is like the original standard line which you drew and then erased. An attentive eye and a good visual memory certainly result from this cultivation.

Fourth.—We should also test the muscle memory. This is the form of memory that every schoolboy uses in playing his games; *e. g.*, in base ball every boy knows what it is that guides him when he "feels for the ball" with his bat. It guides every child in his simplest movements, such as walking, running, leaping, writing, and even sitting. How important then is its cultivation! A simple test, and at the same time a means for such cultivation, is found in the teacher's requesting each pupil to draw on the slate or blackboard a line of a certain length—*e. g.*, four inches, then erasing the line, let him endeavor with *his eyes closed* to draw a similar line. The error can be measured in millimeters and [illegible]ted in per cents. for each pupil.

[illegible] hould also test the child's accuracy in touching a given point. I place before the child a card upon which there are several small dots and request him to touch one of the dots with a pencil, the arm being held free above the desk. His hand will not move to the exact point which his will commands and he is sure to make some sort of an error. After he makes a dot, you can measure the error by taking a ruler or a pair of compasses estimating the distance between the original dot that you designated for him to touch and the one actually made by the child.

Another interesting test, but at the same time exceedingly simple, is to lay before the child a sheet of paper upon which there are two dots separated by a distance of from three to five inches. Ask him to connect the two by a straight line, the paper being so placed that such a line will necessarily be horizontal. To measure the error of the child, for he surely will make an error, lay a straight ruler across the dots and you can easily detect the deviation from the true straight line.

Thus I might go on and suggest a half-dozen tests for each of the ten or twelve senses. Tests for vision, hearing, taste, touch, temperature sense, pressure sense, sense of motion, and the like; but these that I have given will illustrate what is meant by the measurement of faculty. A few general statements are, however, necessary.

Two elements enter into all education — first, organism; second, environment. Both are of the greatest importance, both must be thoroughly studied. Any method of teaching that fails to consider the content of the child's mind on entering school and fails to take note of its tendencies to development must end in failure. Very often repressive measures that quite paralyze his nature are employed in order to adapt his organism to the environment, instead of adapting the environment to his organism.

Again all education must begin with the education of the senses. Not any single sense but *all* of them, if you would have an evenly developed pupil. Too often we think we are teaching "observational studies" if we appeal only to the eye, forgetting that there is an observation of the ear, of the finger, and of all the
of sense, as well as the eye. Furthermore, every pupil on

school is one-sided in his development. His hand has been developed at the expense of his eye, or his eye at the expense of his ear, and so forth. Now the teacher can, by means of such simple tests as those I have hinted at, tell just along what lines his pupil has been developed, apply the correctives and guide him accordingly. Thus it is that Experimental Psychology has justified itself in offering a sure and exact method of investigation into the content of a child's mind with a view to its best development.

LESSON XXVI.

CHILD-STUDY: THE BASIS OF EXACT PEDAGOGICAL METHOD.

THE importance of the study of children is beginning to be recognized as one of the prominent features in the search for practical methods to employ in the education of children. In former years the study of educational methods was entirely confined to the study of mere theories; but little by little educators have come to see that after all it is of much more importance for teachers to study the minds of their pupils as they come into contact with them day by day in the schoolrooms. Never before in the history of education has the importance of the study of Psychology been recognized so widely as at the present time. Every teacher is inquiring as to the best and most helpful text-book for this particular line, thinking that a book will be able to supply the required need; but scientific child-study means more than the hearing of lectures or the study of systematic Psychology as presented in the various formal text-books. Prof. Royce expresses the matter well when he says: "First, then, let the young teacher remember that it is not the system of psychological science nor the exhaustive theory of the power of the human mind that he needs, but rather the *psychological spirit*; that is, the love and skill that are required for the purpose of mental diagnosis." While I would be the last to yield to an undervaluation of the study of Psychology in the formal way, I sincerely believe that the greatest practical benefit it can render to the teacher consists in the help that it can furnish him in his study of the child's mind. It is gratifying to know that this new zest for this eagerness to make the child's mind an open precedence of all other discussions in our edu
It is also a source of gratification

that the study of children is the most practical of all possible studies, for it relates to the mental health and to the economy of human energy. Indeed, it is the only thing that can give an exact scientific basis to educational methods, for education means nothing more nor less than to make the finest specimen of manhood and womanhood possible; to produce an individual rich in strength, developing the child to its fullest maturity in size and power.

The question is often put: "Is there not great danger in allowing teachers to experiment upon children?" The answer of Colonel Parker cannot be improved upon: "Not a tithe of the danger there is in allowing supervisors to prescribe methods, and rigidly enforce the literal following of a course of study. The most awful experiment is to put a girl, fresh from the high school or a cram examination, without a scintilla of the art of teaching, or a faint suspicion of it, in charge of fifty immortal souls; and next to that, even more awful if possible, to put a college graduate, chock full of conceit and of little else, at the head of a school. Thousands of schools are now in charge of principals who have not the faintest idea how to direct and teach teachers. There must needs be experiments, but let us have those experiments which are prompted by an all-controlling desire to do good rather than the experiments of ignorance. The strongest influence of a teacher consists not in his teaching of itself, but in his attitude towards knowledge, and its relation to education. If the teacher is everlastingly in love with knowledge, if this love speaks in his eyes and charms in his manner, little else is needed to make his pupils lovers of knowledge. If the teacher is thoughtfully studying the needs of each of his pupils, and striving to apply the best conditions for the highest self-effort, he is not an experimenter in the common acceptance of the term; the difference is world-wide between an investigation in the sense of studying a profession and an experiment which implies the destruction of material used."

T[illegible]eld of child study for the teacher comprises more than [illegible] rictly included in the term "Psychology of Childhood."

The teacher is, and must be interested in anything that affects the child's activity, his growth, health, and ability to work. Such child study must include every investigation or observation of children that has any relation whatever to education. A new and simple method, much more practicable than that in vogue so long in Europe, in which the results were expressed in forms of complicated tables and unintelligible curves, is that devised by Principal E. H. Russell, of the Worcester Normal School. It may now be employed elsewhere, but it has been worked to the best advantage in this particular school, in which it had its origin about eight years ago. Professor Russell does not limit the field of observation by proposing certain definite questions as to the habits, reasoning, feeling, likes and dislikes of the child, and so on; but prefers to have his corps of pupils and well-trained graduates note any salient act or remark of a child in an exact manner. These records are then filed at the normal school, placed in groups under certain convenient headings, such as imagination, memory, anger, fear, deceit, reasoning, etc. These topics extend over the whole domain of Psychology, and the best and most typical of these records are employed in teaching, instead of using a cut-and-dried text-book. To make them more practicable, as well as accessible to the uninitiated, Mr. Russell has avoided tabulating them, but is publishing them as they stand in short paragraphs, where they can be cited by any one, on simply referring to certain numbers and chapters, as one would to a Bible verse. For example, under the chapter, "Reasoning of Children," you will find the following paragraph, numbered "204:"

> [Child, four years old.] E.'s mother is afraid of cats, and hates to touch them. E. did something, and his mother said she was going to whip him for it. When she said this, E. was standing near the door and he went out. In a few minutes he came in with the cat in his hands. He got very near to his mother, and then said, "Now, mamma, if you lick me, the cat will bite you all up." Mother.—"E., let the cat go out." E.—"Will you lick me? If you do, I won't let the cat go, and he'll scratch you, if I tell him to." Mother.—"Well, I won't lick you if you let it go." E. let the cat go, and laughed for a long time; and ever since then, if she says anything to him, he will say, "Mamma, I'll g[illegible]t!"

Under the rubric, "Imitation," we find such paragraphs as these:

S. watched her children during a recess. "Two children began to play 'see-saw' (a game in which children take each other's hands, and sway, back and forth in rhythmic motion). In about two minutes as many as 34 out of 50 children began to play it."

"I have been watching W. and L. for a number of months, and I find that, almost without exception, if one does anything, the other will imitate it. Both have small rocking-chairs, and if W. sits down in his chair, L. will also sit down in hers. If L. rolls marbles on the floor, W. will also."

"Bessie was digging in the snow, and her cloak was unbuttoned and flying open. I said, 'Why, Bessie, why don't you button up your cloak?' She answered, 'Don't you see I'se working like a man, and mans has their coats unbuttoned?'"

The collection of such data as these cannot help but have a most excellent effect upon teachers. Their attention is diverted from abstract themes and mystifying discussions, and focused upon the concrete child as he lives and moves and has his being in the average school. Indeed, the best result of this sort of work is the effect upon the teacher's own life and methods of instruction, freshening him and keeping him in loving, conscious contact with the child he is endeavoring to lead. So noticeable has this been that Principal Russell makes the statement that the "practice of child study is directly for the sake of the teacher, indirectly for the sake of the child, and incidentally for the sake of science." The object of such study is best set forth in the official statement sent out by the school to former pupils who are now engaged in teaching work, as well as to others interested in this sort of investigation: "The Principal requests the students to observe the conduct of children in all circumstances — at home, at school, in the street, at work, at play, in conversation with one another and with adults—and record what they see and hear as soon as circumstances will permit. When the nature of the work is explained to the school, great emphasis is placed upon the necessity of having the records genuine beyond all possible question; of having them consist of a simple, concise statement of what the child actually does or says, without comment by the writer; of making both the observation and the record without the knowledge of the child; and of noting the usual, rather than the unusual, conduct of the individuals observed. For convenience in classification, blanks of five colors are provided for the records. White paper is used for such observations as students make themselves; red for well-attested ones reported by others; yellow for reminiscences of their own childhood; green for mention of whatever they read on the subject; and chocolate for observations that extend continuously over a period of time."

About 15,000 such reports have been made, and, as we have already intimated, among them are recorded many interesting and valuable observations. The teacher in making these observations has become thoroughly interested in the varied activities of the child. As Professor Burnham well says, "This work cannot be commended too highly as a means of bringing the young teacher into relations of interest and sympathy with children."

We must now allude to the subject of measurement, or anthropometry, as applied to the growing child. Professor Bowditch, of the Harvard Medical School, took the weight and height of 25,000 Boston pupils. He found that until the age of eleven or twelve, boys are taller and heavier than girls. The girls then begin to grow more rapidly and for the next few years surpass boys in growth, height and weight. The boys, however, soon overtake and surpass them and thereafter remain taller and heavier. It was also found as a result of these measurements that children of American parents are taller and heavier than children of foreign parents, and Dr. Bowditch makes the practical suggestion that mental effort be reduced during this period of rapid growth. Dr. Peckham, Superintendent of the Milwaukee City Schools, when Secretary of the State Board of Health, measured 10,000 Wisconsin children. Among other conclusions he makes the following: The growth of the body and of the lower extremities takes place in such a way that the strength of the body of girls is less than of the body of boys until the tenth year, and thereafter greater until the sixteenth year. From 15 to [illegible] bodies of girls grow only two inches and the bodies of [illegible] ur inches. Measurements much more complicated than these have been devised by Dr. Franz Boas, who has made accurate statistics from measurements of six large American cities, over 30,000 children being measured in St. Louis alone. These results were presented in graphic form at the Chicago Exposition in the Anthropological building, and are now being published.

In 1892, Dr. W. Townsend Porter began a series of investigations upon the children in the St. Louis schools, with a view to determining whether or not there is a physical basis of precocity and dullness. These investigations extended over a period of eleven weeks, and included measurements of weight, height, length and breadth of the head, vital capacity of the chest, acuteness of vision, and many others—no less than 33,500 boys and girls being examined and measured. The great store of facts thus secured has been used to determine the laws of the normal growth of St. Louis children, in the hope that, on such a sound basis, there may be established a system of grading which may take into account the physical capacity of the pupil in the assignment of school tasks. Only when the laws of growth are accurately known, is it possible to decide with certainty how much the growth of an individual exceeds or falls below the normal average; and without this knowledge, the regulation of mental labor, from a physical standpoint, is a venturesome groping in the mist, rather than a scientific deduction. Of all methods, none is more useful than weighing; partly because it is easy to weigh, and partly because weight has a more intimate relation to strength. The weight, in fact, may be looked upon as an indication of physical development. By weighing, Dr. Porter sought to answer three questions: Are there dull children, who are in the main weaker; and precocious children, who are stronger than the average child? Is there a physical basis for precocity and dullness? Is mediocrity of the mind associated, in the main, with mediocrity of physique? All of these questions, as results of his thorough-going investigation, are answered by Dr. Porter in the affirmative. The truth which the investigations exhibit is very plain.

They declare in unmistakable words that precocious children are heavier, and dull children lighter than the average child of the same age. These investigations establish a physical basis of precocity and dullness. A deduction of the greatest practical importance is made from the laws established by this interesting piece of research work: No child, whose weight is below the average of its age, should be permitted to enter a school grade beyond the average of its age, except after such a physical examination, as shall make it probable that the child's strength shall be equal to the strain. Incidentally, it was also shown that children have too many hours in the schoolroom, especially in primary grades. Three hours a day are enough for pupils in the first three grades. Three morning hours in the schoolroom, and two afternoon hours spent in study, would greatly enhance the quality of the work done.

It is interesting to note that more children are measured in this country than in any other, but it is not being carried on so well, so scientifically, so accurately as in France and Germany; but enough in the way of results has been secured to show that each part of the body has its own nascent periods or growing fits. Growth focuses now upon one set of organs and functions and now upon another. The eye, hand, arm, chest, fingers and other organs and functions each have nascent periods, during which they grow far more than for a long time before or after. Do not nag a child with methods at the time of rapid growth. Turn him loose, permitting him in a measure to roam at will, following his most natural impulses, assuming as few trying mental burdens as possible.

Another subject of investigation that will be most fruitful of results is the study of fatigue. Fatigue, we know, arises from over-exertion, either mental or physical. It varies with the condition of the mind and body. Thus the child tires sooner when the work is distasteful, or when the organs are unhealthy, or when the body is poorly nourished; and the body is also wearied quicker when the mind is tired, and the mind more quickly when the body is tired. For the conclusions of experimental investigation [illegible] the subject of the influence of bodily fatigue and mental fatigue upon each other, I need only refer you to the account on page 43. The child tires more readily at some seasons than at others. The condition of the atmosphere, the weather, the time of day, all these affect the normal power of endurance. Also rapid growth, as already intimated, diminishes one's power of endurance. The child that has grown up too quickly tires easily. One of the early effects of fatigue is in the difficulty of fixing and holding the attention. The condition of the strain brought upon the will in compelling the attention makes work fatiguing; the mind being thus taxed, a conflict between what it feels has to be done and a preference for something else is continually going on, and this strife involves a worthless expenditure of energy and a waste of time. Fatigue causes the mind to be less sensitive to interest or novelty. The mind of the tired child may be active, but at the same time it is scattered and poorly directed. The great curse of this age is the demand for rapid education. In the hurry to go through college and complete a university course, many a person is sacrificing the very thing for which they seek, namely, the power to think and do. Certainly the results that ensue in consequence of over-pressure in the town and city schools are criminal. Superintendents, teachers and parents push and crowd the children through a long, hard year's work. Health is sacrificed for promotion, and the joyous, buoyant child is burdened with unnatural demands until such a thing as natural mental spontaneity is unknown. What is learned when a child is fatigued is soon lost, the mind's forces being easily dissipated. Vital force is required faster than it is generated. The work done to-day is done on to-morrow's credit, and the system of the child is wholly at a loss to protect itself against disease and accident. Some physicians go so far as to say that most diseases have their genesis in fatigue. There is no doubt that constant tension kills not only joy, but growth. When work is performed by a fatigued mind and tired brain, bad mental habits cannot help being formed. Continual over-pressure in childhood certainly means weakened possibilities in adult life. Whatever filters through the mind of the tired child must, of course, receive thereby a coloring. Every one of our thoughts, all of our actions, our plans, our hopes, our ambitions and aims are conditioned by our moods, and these moods are directly dependent upon bodily feeling. The great demand of the age is that we find and establish a science of resting.

Dr. Burnham of Clark University has classified the study of children under two great heads. (*a*) Anthropological studies, and (*b*) Psychological studies. Under the first must be included the investigations in regard to growth and health of school children, such as those of Bowditch, Porter and Peckham already referred to. The Psychological studies fall into three subdivisions: first, the study of sensations; second, the study of the higher intellectual processes; and third, the study of the motor life of the child. In the sensory field the child's power of vision, hearing, tasting, and smelling should be accurately tested. The most thorough-going investigation has probably been made upon the sense of hearing. As a result of the practical investigations in this line, Dr. Barr gives several very good suggestions, of which we have space for but four:

1. Teachers should keep in view the fact that in every class of fifty children, there are probably a dozen or more of them who have some defect of hearing, and who are, therefore, placed at a disadvantage as compared with their normally hearing fellows.

2. Children whose hearing is very defective, or who are totally deaf, should be taught in a separate class by the German method of articulate speech and lip reading.

3. In the case of children whose progress is unsatisfactory, and who are inattentive, dull and idle, their capacity of hearing should be determined by proper tests, and if defective hearing is found, information of the fact should be sent to the parents, and their position in the class so arranged as to minimize the bad effects of the defective hearing.

4. The class room should never exceed twenty feet in length or breadth, or better, a parallelogram of 25x15 feet. The teacher should be at the middle of one of the short sides of the parallelogram, and th [illegible] of scholars in one room should never ex-

ceed fifty. If, as is frequently the case, the teacher stands in the center of the long side of a parallelogram, the children to the extreme right and left are badly situated for hearing.

The study of intellectual processes would include the investigation of their power of memory, imagination, reasoning and the like. Without question the best piece of work that has been done in this line is the study of memory made by Mr. Bolton of Clark University, upon children in the Worcester schools.*

In the motor field are included all the studies of children's languages, their plays, manual work, kindergarten occupations, the development of voluntary control over their motions. The most systematic study yet made of motor ability is that published by Professor W. L. Bryan. He found that the modifications induced by fatigue are greater than improvements due to age; that a child of sixteen, *e. g.*, could tap with the pencil five times as fast as the child of six; that the rate of such motion declined at the age of fourteen in boys, and at thirteen in girls; but was preceded in both by a rapid and followed by a less rapid increase.

It is a source of deep regret that the average teacher addresses himself to the stupid rather than to the bright pupils of the class. In our traditional methods we are accountable for great mental waste, in that we retard and stunt the bright child in order to keep pace with the slow one. It is possible to advance the brighter half faster than we do. It can and should be done. In Paris a few years ago, eighteen average boys were selected and a number of average teachers chosen to guide them in their studies. These teachers said: "Let us do the best thing possible for these boys. Let us help them the most we can." As a result of their painstaking efforts these boys went through the six years of the Lycée in *two and one-half years*, without the slightest trace of physical impairment. If we have learned that there is such a thing as mental waste, we should remember, too, that there are also certain great principles of mental economy.

We should reconstruct all on the basis of the child. The living, playing, romping, rollicking child embodies a truly elementary Psychology, and every great educational reformer who has spoken authoritatively, has been a person who lived for years in closest touch with children. Teachers, as a rule, fail to study the nature of the child in a thorough-going way, for no less than three reasons: (*a*) They regard it their business to impart instruction, or infuse information, rather than to "e-ducate" or unfold. (*b*) They are conceited enough to think that they have sufficient knowledge of childhood in their own remembered experiences of their early years, forgetting that these few tattered, musty remnants are incidental rather than characteristic. (*c*) Many think a text-book on Psychology supplies the need. This is the gravest mistake a teacher can possibly make.

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* "American Journal of Psychology," April, 1892.

In the discussion of the value of different studies, take for example, the controversy that has so long been waged between those who believe that Greek and Latin should be retained in the curriculum, and those who do not. Has this momentous question ever been discussed on the basis of the real nature of the child? If we take the point of view of those who indorse the study of the ancient languages, what a waste of time and educative power there is for the modern courses of study, which draw at least three-fourths of the pupils in the public schools of this great national commonwealth! On the other hand, if we take the opposite view-point, we find ourselves raising a hue and cry over the waste of time and opportunity going on in colleges and preparatory schools over dead languages, no longer of practical use. The ringing words of our wide-awake Commissioner of Education, Dr. William T. Harris, should be heeded by all interested in curriculum-making: "It is indeed high time that the collective mind of the fraternity of educators should be turned to the subject of educational values."*

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*"Educational Review," January, 1894.

APPENDIX.

THE KINDERGARTEN AND CHILD DEVELOPMENT.

[The following chapter was written by Miss Kate Cary, the direc
the kindergarten at Champaign, Illinois, the seat of the State Unive
Miss Cary was one of those in charge of the Model Kindergarten
Illinois Building at the World's Fair from May to August. That
not only a successful kindergartner, but a keen psychological stude
well, is clearly shown by the context of this article, for which the a
is under great obligations.]

FRŒBEL based education on unity. He desired to sho
child the world as a whole and to see himself as a part of
great whole. Living in perfect harmony with all things, s
dinating himself to the welfare of his fellow-men, to see l
nature, in spirit, and in man who connects both.

And this he would have developed through *self-activity* i
child, not meaning that the child shall learn only by wh
does himself, but that his whole self, every phase of his b
shall be active and alive in receiving and giving.

And to carry out this all-sided development of head, hear
hand, he has given us games, songs, gifts and occupatio
awaken every faculty of the child, and through the mediu
play, connect the unknown with the known. And it is this
of play in the kindergarten that has caused the unthinking
to call it a good place of amusement for children, only admi
its true value in cases where children have little or no traini
home.

That it is a good thing for the poor, neglected child c
streets I gladly agree; but is it not true that the child of we
allowed only the freedom of the nursery's four walls, is qu
much to be pitied as the less-cared-for child of poverty?

Go from a kindergarten of waifs into one of more fortun born children, and see the marked difference in self-denial and generous thought for others, and then say that the little ones of wealthy parents do not need the development of the kindergarten.

I care not whether a child comes from a home of love or neglect, it is the atmosphere of sympathy in the kindergarten that opens his heart and helps him to display the true nature. Here it is that he meets children of different homes, of different types, having various characteristics, making for him a community in which all hold equal rights. It is where he first learns law—law according to his age. All our children, rich or poor, high or low, fall under the same group of mental and moral laws. Nature made only one set of educational laws, as she made only one kind of sunshine. It is a place of experiences, where he gets the presentiment of the life that lies before him. The kindergarten is his, he feels the importance and responsibility which give him the self-respect necessary to growth of character.

It is not only that the mother's time is occupied with household cares, social duties and the physical needs of her child; the mother at home with one, two, or perhaps three children though she be born and bred a kindergartner, cannot do for them what the kindergarten can with its twenty-five. I would not have the home life left outside the kindergarten door, nor the kindergarten life left inside; they should be parts of the great whole, one strengthening the other, and experience shows this to be true.

Watch a few carefully reared children enter a kindergarten in October, and follow them until June and see the change, if the kindergarten be a true one, and I would speak of no other. The selfish, peevish child has been led to submit to the other twenty; the self-conscious child is made unconscious, the weak becomes stronger, and all have learned to obey the laws set for them, and are made more capable of filling their places in the larger world. One by one come to their little minds the principles of love, justice and beauty, and they are made free. Its reaction in the poor districts is of course much greater. It not only affects the child and family, but the entire neighborhood. I have seen some of the hardest eyes soften as they watched the happy babes at work, and eyes, where tears had long since ceased to flow, moisten at the song of forty or fifty little ones seated about the circle. And the kindergarten window filled with plants will catch the eye of every passer-by and allure the lowest to stop for a minute. The mothers tell us they can no longer use harsh words since the kindergartner does not.

The visits of the kindergartner bring great pleasure and pride to the parents, and I have been into rooms where the only ornaments were the well-preserved work of the child at kindergarten. The marked condition of improvement shown each year in the children's body and clothes tell that the kindergarten has crept into the homes to stay.

The deepest truths of humanity are revealed in the methods of the kindergarten. Frœbel saw in each child all of the germs of the coming man. He saw that the development of each individual depended upon a law, the law of continuity, each succeeding phase arising from a preceding one and depending upon it. He saw that everywhere in nature, life and growth seemed to be a gradual change from a lower state to a higher with no breaks; and he saw, too, that everything in nature had its own individual method of development, and to force it this way or that would either hurt or kill, but to wisely prune brought perfection. And so with the child who manifests characteristics as many and varied as his physical ailments, each one is worthy of being recognized and given fair play. And this can be accomplished only by the freedom allowed in the kindergarten. He would have us lead the child into a happy, receptive mood and then *let* him receive, for when the ground is ready, seeds of all kinds easily germinate, in obedience to rules. Love and harmony will be expressed, because felt. Upon asking a University girl, who was fortunate in having had both home and kindergarten training, what made the most lasting impression upon her, she said that the beautiful, harmonious atmosphere which pervaded the kindergarten room could never be effaced from her memory.

With children, awakening and cultivating the love of the beautiful furnishes a better ethical basis than moralizing. The story with a deep hidden meaning is felt without the tacking on of the moral. One of the apparently worst of boys that I ever saw would stand morning after morning in deep thought before a picture of the Mother and Child on the kindergarten wall, conscious for the time of nothing else about him, and over his face would come a most beautiful smile, only to end in some low word when he found the eyes of another child upon him. One morning his eyes were caught by the picture of Raphael's Cherubs, and he whispered to his brother, "Roy, I see angels, one's looking at me and one aint." From that time a new life sprang up within him, which slowly but surely strengthened, and he left the kindergarten a different child, a marvel to his parents and neighbors.

The desire of the kindergartner is to find the good, strengthen and develop it by self-activity, and let the bad fade away, dying of atrophy; not keeping the child always out of harm's way, but getting the love of right deeply rooted. Then wrong may come, the child is safe.

Forms of beauty are used to cultivate the taste for the beautiful. Color is taught to cultivate observation, to develop, strengthen and purify the life of the child by lifting him out of himself and leading him to see and feel beauty in nature and art, and to strive after that which is high and noble. The greatest task of our times is that of giving each young person a first impulse toward the world of truth, beauty and right; but these will be nothing to the child until it has learned to love something. Frœbel saw this and so he said, take the child at the symbolic age of three years, and give it a chance to play with forms, tasks and ideas which are symbols of the utility and beauty to be met with in after life.

And so the kindergarten meets the child on its own ground— the ground of play. And it is this freedom of play and self-activity that gives the kindergartner insight into the child's inner nature and affords her the opportunity of seeing in what the child is weak. Under this head of play would come the presenting of new thoughts in an attractive manner, the value of which is so forcibly illustrated in the kindergarten. For example, the fall thought of the seeds, so wonderfully cared for by Mother Nature, presented by a simple truth, clothed in an attractive manner and connecting the thought with the child's own life and experience, will arouse the most intense interest. Little "seed cradles" and "treasure boxes" will be brought to kindergarten as long as King Winter leaves any uncovered—some such tiny treasures, that an older person would discover them with difficulty, which show how the eyes of the child have been opened to the beauties growing by the wayside. And when spring comes, what boundless pleasure is expressed in taking off the coat of the soaked pea or bean and finding the baby inside so carefully provided for—plenty of food and warmth to keep it alive until it is time to be born. In presenting the thought in this way, the child sees the life about him, not as a separate thing, but as a part of the great whole of which he is but another phase.

I once saw a kindergartner take up a pot of earth in which was growing clover—the seeds having been planted by the children some days before—and calling one of the children to her, asked him to pull up a few of the little plants, for they were growing too thickly. In response, his hands crept back of him and were tightly clasped, while his head shook *no;* and in wonderment he looked up into the face of the kindergartner, whom he wanted to please, every feature asking how she could expect him to do a thing so cruel to a little life he had helped give birth, and carefully tended for days. Need we fear for that child's future? How the child's spiritual eyes are being trained as he searches on his way to kindergarten, to see what nature has that will give pleasure to the other children. The song of "Come, Little Leaves," will fill the room in a short time with leaves wearing the most gorgeous dresses of red, gold, or brown, like "Mary's dress" or "Joe's tie." It is a happy morning when one boy who has needed an extra amount of sympathy in lessons of nature, calls out that he "didn't know leaves growed so nice."

A mother was heard to complain because that "foolish kindergarten did nothing but teach her child to hunt flowers and leaves, and when she took him out for a walk, he was so intent upon finding new colors and forms that he did not 'keep up.'" Oh, mothers! let your children lag behind in the walk, *but not alone.* Give them your sympathy, for they are advancing in a much more important walk, than the one they started out to take.

Besides the deep impression made upon the mind by a thought presented in a pleasing manner, an infinite amount of time is saved. In visiting a primary school I saw the teacher trying to make children of eight and nine years realize that blue and yellow mixed produce green, by merely telling them the fact—the words went in one ear and out of the other, as I found upon questioning the next day. The child in the kindergarten is given a little yellow paint, and a little blue, and is told nothing. He mixes them, and after many exclamations paints his leaf—*the fact has come to stay.*

Objects talked about in the kindergarten are examined individually, each child thinking and expressing thoughts for himself, and this disposition to attack and wrestle with a thing—which I am told is a marked characteristic of the kindergarten child when he enters school—is strengthened by making the child first, keeping it in the foreground, and the director in the back; *this makes the child think his own way and develops him by means of his own activities.* The great need of the child is for him to be led to work by himself, with skillful guidance, and wise encouragement and recognition of his efforts. The school teacher often complains of the child's "tiresome why," and desire for recognition for his well-doing. Is not the first his right, which ought never to be killed? And as to the latter, do we not ourselves all feel the need of recognition of some sort in return for a great effort made? The true kindergartner only gives her smile or nod when the effort has cost the child something.

The object lessons in the kindergarten do not stand merely for the study of things, but for the thought back of the thing. The seed is not examined for the sake of that one seed, but to show the care of Nature and to lead the child to see all the great work [illegible] her careful, loving hand. So with the squirrel that gives [illegible] much pleasure; it is not simply this little four-legged [illegible] lives on nuts and makes his home in the trees, but the thought of an industrious fellow, storing up food for the winter, always busy, never idle, hence happy. And so in color, the child is not taught that the apple is red, or lemon yellow, only as belonging to the apple and lemon, but to open his eyes to all color and to universalize it.

The games in the kindergarten play an important part, we might almost say *the* important, if there were any one part of more consequence than another. Excepting the child, they constitute the important feature of the kindergarten. Through the the games muscles of the body are brought into play, and by developing muscular force the will is strengthened; and grace and beauty of mind and spirit increase in proportion to physical grace. For we know it is one of the demonstrated truths in modern Psychology that body and mind are under reciprocal relations—that body acts on mind and mind acts on body. Every mental act leaves its impress upon the physical organism, and every bodily modification in turn affects the mind in its activity, growth and development. In these games, so simple to the casual observer, the child is developing gentleness, self-sacrifice, self-reliance, promptness, courtesy, freedom of thought and action. And these same games bring the children into close union, and develop a mutual dependence and sympathy; they foreshadow and present great truths. The various family relations, duties and moral virtues are strongly inculcated. In what way can a deeper love for, and clearer mental picture of the birds and animals be obtained than by the child's representing them in the games at the circle? The many trade games reproduced in the kindergarten tend to quicken the child's sympathy with his fellow-men.

Then comes state life, with George Washington as a type of strength and beauty. How can a stronger lesson in patriotism be imparted than by making the child acquainted with the flag? As he bears this emblem of his country in the marches he is insensibly being trained for patriotic service. One is interested to know that in New York City at certain schools one of the first lessons taught the young children of the foreigners is to respect the flag of the United States. Accordingly they salute it at the beginning of each day's work. This, accompanied by right teaching, will result in stronger love for country.

Following the state life is the church life, and spring, symbolic of life and resurrection, is developed by the child representing in his own way the seed and its growth, the worm and its awakening into a butterfly, and the returning of the migratory birds. Sharing the life of nature and of man, the child feels himself one with both.

The sense games serve an important function in the development of the child. His senses become wonderfully sharp and acute by means of the exercises accompanied by bright, attractive words set to good music. They give him endless pleasure and help him to express in definite terms the impressions made. Allowing the child to glance for a minute at a collection of objects and then letting him tell what he has seen, strengthens memory as well as sight; looking at a picture in the same way; guessing which child has left the ring; giving them mild contrasts in smell and taste (mild that these easily fatigued senses may not become overtaxed); objects to feel of; kinds and direction of sound; finding things to loud and soft music, or telling a playmate by his voice or step—in such ways the little ears are trained to hear and the eyes to see much more quickly and accurately than our dull, untrained senses. And this habit of contrasting smell, taste and sound will not end with material things, but be carried on into higher contrasts. Judicious direction in these sense games, as in all else in the kindergarten, must be exercised. If played too long the child becomes tired, and inattention and dissipation of the mental forces will result. The games of contrast, of smell, taste and sound are illustrated in the gifts by contrasts of color, form, size, number, relation, direction and position. Their purpose is to foreshadow and prepare the way for truth, to present striking contrasts, to acquaint the child with normal types and to develop creative activity. By means of the gifts the child is led to analyze, abstract, compare, and classify, of course unconsciously and through play. In them Frœbel has met every desire of the child. Beginning with the ball from its simplicity and unity, he leads out to the sphere, cube and cylinder, which stand as types of the animal, vegetable and mineral kingdoms, offering contrasts of form. From this he goes to the divided cube, which meets two strong tendencies of the child, to investigate and reconstruct. The first divided cube presents contrasts in size, the second contrasts in division, the third contrasts of angles, and the fourth repeats and emphasizes the contrasts of the preceding gifts.

The significance of these divided units lies in the relationship of parts to each other and to the whole. Their essential object is to develop the constructing powers of the child, thus counteracting the destructive tendencies which would develop unduly were investigation alone provided for. They offer illustrations of fractional parts; halves, fourths, and eighths become clear with the right use of the cube divided into eight smaller cubes and those divided into eight oblongs, while the cubes of the fifth and sixth gifts by their larger number of divisions illustrate thirds and ninths, also halves, quarters, sixths, twelfths, and twenty-sevenths. With the tablets more subtle contrasts in form are presented. By means of sticks of various lengths any number of exercises may be given in counting, adding, multiplying and subtracting. A little fellow once replied to his kindergartner, who said she didn't suppose he could count four, "I didn't, I seed two sticks and two sticks and I thinked four." All of these exercises are done through play, at first to arouse interest in the relations of numbers; later, mechanical drill may be given with great delight to the child.

The child gets the rudiments of geometry in making the different forms with his gifts, connecting them at first with some familiar object—searching for them about the room, out of doors, at home, and when quite familiar with a form is told its name. For example, the honey-comb is examined, then represented with the fifth gift, tablets and sticks, sewn on card-board, drawn and painted until the child has a good mental picture of [illegible]d can tell in good language how he made it and of what it is [illegible]osed. The gifts are a "key to the inner world and a door to the outer." What a child has taken in he *gives* back to the world through his fingers by means of the gifts, before he is capable of expressing in words. The child must know the things that words describe before he can give expression to them.

The contrast of color, form, size, number, etc., illustrated in the gifts, are applied in the occupations—which are more or less imitative at first, for the child must be master of his material before he can use it as a means of expression; but just as soon as he is strong enough, he is given material to carry out in his own individual way, impressions made by the gifts. And that is why clay and sand are so valuable to the child; he feels himself master of that pliable material from the start, and finds delight in producing a mental picture in the clay every time he is given a chance. And the products are often so full of life that you marvel at the clear thought of the child. He absorbs from the occupations, principles of industrial and art education; he sees proportion and harmony of colors, and learns to look for them in all that surrounds him.

No bent bodies are allowed, the fingers become more skillful. In the gifts and occupations the ability to use both the right and left hand is developed. The desire for neatness, order and accuracy is strengthened and no careless work is accepted.

The quiet, orderly way of working with the gifts and occupations assists in quiet, orderly thinking. Doing truth with the fingers will help the child to act and feel truth in his soul. This continuity of thought in story, song, game, gift and occupation in the kindergarten, strengthens the child's powers of concentration. His interest is aroused at the opening circle, and each game, each task, and each thought, bears upon the topic for the day or week. The dictation in the gifts and occupations carrying on the thought of the day is simple and within the child's power, and teaches him to hear. It is amazing to see the stupidity with which young ladies in the training class take such dictation as that given young children. The child's interest grows deeper with each effort made, and he falls quietly and happily to work. The material used in carrying out a thought is so varied—each day being different—that the child does not become fatigued, and in the use of the gifts he is never allowed to tire of them; he is given dictation fifteen minutes, and is allowed free play for the same length of time, so that each week the child welcomes the gifts as he would a new toy.

Statistics show that this concentration of thought is not dropped in the kindergarten, but follows the child in all his future work. The kindergarten children are said by school teachers "to know how to talk." This is simply because they have been allowed free expression of all the impressions made, under the careful guidance of the kindergartner. The child who enters the primary school from the kindergarten, is said by the majority of teachers to have greater power of attention, is more obedient to the rules, school life not being so new as to a child fresh from home; and the bashfulness which keeps some children months from learning, and cannot claim from the busy school teacher the attention necessary to help the child, is entirely overcome in kindergarten. Other teachers say the child is more active, wanting to be kept busy and interested, and is hard to make conform to the rigid rules of the public schools.

But all, I believe, are of one mind in maintaining that the kindergarten child is brighter, more self-reliant, is able to express himself better, and has the power of observation most strongly developed. He does not dash ahead of the others, but is given a slow, happy, healthful awakening into school life, and the interest awakened keeps him alive, and ready to grapple with new thoughts that make other children tremble.

If the kindergarten did nothing but give the child self-confidence, it would be doing its full share.

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